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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND ALEX. RICHARDSON.

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VOL. CXVI.—No. 3020.] *LONDON: FRIDAY, NOVEMBER* 16, 1923. [*Registered at the General Post Office as a Newspaper.*] [PRICE ... 1s. BY FOREIGN POST 1s. 3½d.

Aveling & Porter, Ltd., ROCHESTER.
Steam Road Rollers & Tractors. 1108

A. G. Mumford, Ltd., CULVER STREET WORKS, COLCHESTER.
On Admiralty and War Office Lists.
ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See advertisement page 18.
PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

Dredging Plant
OF ALL DESCRIPTIONS.
FLOATING CRANES. COAL BUNKERING VESSELS.
Werf Conrad, HAARLEM, HOLLAND.
Agents: MARINE WORKS, Ltd., Friars House, 39-41, New Broad St., LONDON E.C.2.
See half-page Advert. last week and next week. 1382

CRANES. All Types.
GEORGE RUSSELL & CO., LTD., Motherwell. 1137

STEEL TANKS, PIPES, GASHOLDERS, &c.
Thos. Piggott & Co., Limited, BIRMINGHAM. 1241
See Advertisement last week, page 86.

Spencer-Hopwood & Kirke PATENT BOILERS See Page 81.
Sole Makers: SPENCER-BONECOURT, Ltd., Parliament Mansions, Victoria St., London, S.W.

Tank Locomotives.
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO. Ltd., Engineers, Newcastle-on-Tyne. 1133

Cochran MULTITUBULAR AND CROSS-TUBE TYPES. Boilers.
See page 17. 1134

E. J. Davis, M.I.Mech.E., Gas Engines Inspected, Tested and Reported upon. Over 25 years' experience. Tel.: Maryland 1736 & 1737. Wire: "Rapidising, London." Great Eastern Road, Stratford, E. 15. 1794

Brett's Patent Lifter Co. Limited. Hammers, Presses, Furnaces, COVENTRY. 610

Invincible Gauge Glasses.
BUTTERWORTH BROS., Ltd., Newton Heath Glass Works, Manchester. Od 9753

GEARS OF EVERY DESCRIPTION.
Spring Grove, AUTOGEARS (Leeds), Ltd., Hyde Park Road, Leeds. 1743

Fuller, Horsey, Sons & Cassell. SPECIALISTS in the SALE AND VALUATION of PLANT AND MACHINERY and ENGINEERING WORKS. 1834
11, BILLITER SQUARE, E.C.3.

Iron and Steel
Tubes and Fittings.
Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 817
The Scottish Tube Co., Ltd., Head Office: 34, Robertson Street, Glasgow.
See Advertisement, page 71, Nov. 9.

YARROW & CO. (1922), LTD., GLASGOW.
PASSENGER AND CARGO STEAMERS.
SHALLOW DRAFT VESSELS. 1563

Campbells & Hunter, Ltd.
Gear Cutting.
Worm Wheels cut up to 13 ft. diam.
Bevel and Mitre Wheels planed up to 3 ft. diam.
Spur Wheels cut up to 9 ft. diam.
DOLPHIN FOUNDRY, LEEDS. 4547

VOSPER & Co., LTD., PORTSMOUTH.
SHIP & LAUNCH BUILDERS, Od 3551
ENGINEERS & BOILER MAKERS.

Guillotine Shears and Power Presses
FOR SHEET AND PLATE WORKING.
THE REGENT SHEET METAL MACHINE TOOL CO., LTD., Regent Works, Wakefield. 1668

OIL FUEL APPLIANCES, *Systems* PRESSURE, AIR, STEAM *For Boilers of all types.*
KERMODES LIMITED, 35, The Temple, Dale Street, Liverpool.
Naval Outfits a Speciality, also for Merchant Ships, for Factories, Locomotives, and Industrial Process Furnaces of all kinds.
Supplied to the British and other Governments.
Telephone No.: Central 2832.
Telegrams: "Warmth." 4078

Locomotives Tank Engines
designed and constructed by MANNING, WARDLE AND COMPANY, LIMITED, Boyne Engine Works, Leeds. Od. 2487
See their Illus. Advertisement, page 89, last week.

RAILWAY AND TRAMWAY ROLLING STOCK.
Hurst, Nelson & Co., Ltd.
The Glasgow Rolling Stock and Plant Works, Motherwell. Od 3383

R. Y. Pickering & Co., Ltd. (Established 1864.)
BUILDERS of RAILWAY CARRIAGES & WAGONS
MAKERS of WHEELS and AXLES of all kinds.
RAILWAY WAGONS FOR HIRE.
Chief Works and Offices: WISHAW, near GLASGOW.
London Office: 3, Victoria Street, Westminster, S.W. Od 8353

MACHINE CUT Gears.
Spurs, Bevels, Spiral, Worm and Worm Wheels.
HIGHFIELD GEAR CUTTING CO. (Dept. E), Huddersfield. 1845

Phone—Holb. 541. Tele.—Andrubo, Holb., London.
Andrews & Beaumont, CHARTERED PATENT AGENTS, 1393
29, Southampton Buildings, London, W.C. 2.

ON ADMIRALTY LIST.
John Kirkaldy, Ltd.,
London Office: 101, Leadenhall St., E.C. 3.
Works: Burnt Mill, near Harlow, Essex.
Makers of
Evaporating and Distilling Plants.
Refrigerating and Ice-making Machinery.
Feed Water Heaters.
Evaporators.
Fresh Water Distillers.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers.
&c., &c. 1586

John Bellamy, Limited, MILLWALL, LONDON, E. 1216
General Constructional Engineers,
Boilers, Tanks, & Mooring Buoys
Stills, Petrol Tanks, Air Receivers, Steel Chimneys, Riveted Steam and Ventilating Pipes, Hoppers, Special Work, Repairs of all kinds.

IRON & STEEL
Tubes and Fittings AND Steel Plates.
STEWARTS AND LLOYDS, Ltd.
GLASGOW - BIRMINGHAM - LONDON.
See Advertisement, page 91. 1111

Peter Brotherhood Ltd., PETERBOROUGH.
STEAM ENGINES AND TURBINES.
GAS AND OIL ENGINES.
AIR COMPRESSORS.
REFRIGERATING PLANT. 1475
See Advertisement, page 51, Nov. 9.

Gearing for Power Transmission.
Including Machine Moulded GEAR WHEELS up to 10 feet dia.
FLY WHEELS (rope or spur drive) up to 28 feet dia.
IRON CASTINGS up to 15 tons each, in Loam, Dry or Green Sand;
ENGINES: "Uniflow," "Corliss" or Drop Valve.
BREAKDOWN Repairs a speciality.
CLAYTON, GOODFELLOW & CO., LTD., Atlas Works, BLACKBURN. 1249

The Glasgow Railway Engineering Company, GOVAN, GLASGOW. LTD.,
London Office—12, Victoria Street, S.W.
MANUFACTURERS OF
RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS AND AXLES,
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 1234

Patents DESIGNS AND TRADE MARKS IN ALL COUNTRIES.
E. P. Alexander & Son,
Chartered Patent Agents,
303, HIGH HOLBORN, LONDON, W.C.
(Established 1874.)
Telephone: Central 7434. Od 585

Rosser and Russell, Ltd., Mechanical Engineers,
QUEEN'S WHARF, HAMMERSMITH, W.
Undertake SPECIAL MACHINE WORK of any description.
WELL EQUIPPED SHOP.
LATHE WORK up to 10 ft. diameter.
'Phone: Hammersmith 31, 967. 9211

Henry Butcher & Co.,
AUCTIONEERS, VALUERS AND SURVEYORS for ENGINEERING AND ALLIED TRADES and INDUSTRIAL PROPERTIES. 9660
63 and 64, CHANCERY LANE, LONDON, W.C.2.

Machine Cut Gears
Spur and Spiral.
Worms and Worm Wheels.
Worm and Spur Reduction Sets.
High Grade Work at Reasonable Charges.
STORR & EVANS, Grove Road, Hunslet, Leeds. 1573

Carels Diesel & Steam Engines. 1130
Carels Diesel & Steam Engines (London) Ltd., Kinnaird House, 1, Pall Mall East, S.W. 1.
Telephone: Regent 3484.

Royles Limited, ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, } ROW'S PATENTS.
Merrill's Patent TWIN STRAINERS for Pump Suctions.
SYPHONIA STEAM TRAPS, REDUCING VALVES.
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 5732

YARROW & CO. (1922), LTD., GLASGOW.
LAND AND MARINE
YARROW BOILERS. 1563

Matthew Paul & Co., Ltd., Dumbarton. 1483
Levenford Works,
See Full Page Advt., page 38, Nov. 9.

Forgings.
Walter Somers, Limited, HALESOWEN. 7116

Taylor & Challen Presses
For Production of SHEET METAL WORK, COINAGE, CARTRIDGES AND GUNPOWDER.
Foundry, Works, and Showrooms: BIRMINGHAM.
See advert., page 82, Nov. 9. 8193

"Delta" Brand HIGH-CLASS ENGINEERING ALLOYS.
Forgings, Castings, Bars, Sheets, Wire, Tubes.
THE DELTA METAL CO., Ltd., 1334
E. GREENWICH, LONDON, S.E. 10 (& at Birmingham)

Railway Switches and Crossings.
T. SUMMERSON & SONS, LIMITED, Darlington. 1312

DAVID BROWN & SONS (Hudd.) Ltd.,
Lockwood Huddersfield.
HIGH CLASS
Machine Cut Gearing
FOR EVERY PURPOSE. 1440

For Your Repairs or any SPECIAL MACHINERY, try THOMAS HUNT & SONS, Albion Ironworks, Bridge Road West, Battersea, S.W. 11. Est. 1854. 1642

Special.
TWO HUNDRED HOME and FARM LIGHTING SYSTEMS—New—Complete with battery jars and wire connections of standard American make—fully guaranteed by well-rated manufacturer. Offered at one-half manufacturing cost for special reason. Packed for export, F.A.S., New York. INQUIRIES INVITED for all or part.
G. ALLEN REEDER, Inc., 220, West 42nd Street, New York City. C 97

Centrifugals.
Pott, Cassels & Williamson, MOTHERWELL, SCOTLAND. 1676
See half-page Advertisement, page 74, Oct. 26.

The Manchester Steam Users' ASSOCIATION.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.

Chief Engineer: C. E. STROMEYER, M.I.C.E.
Founded 1854 by Sir WILLIAM FAIRBAIRN.

Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 1311

In the High Court of Justice. 1923.-P.-No. 2627.
Chancery Division.
MR. JUSTICE ASTBURY.

IN THE MATTER of Letters Patent granted to BERNARD ROBERT PARKINSON and HENRY WOODALL for Improvements relating to Securing the Ends of Service Pipes to Gas or other Mains, bearing date 23rd October, 1907, and numbered 23414 of 1907,

and

IN THE MATTER of Letters Patent granted to BERNARD ROBERT PARKINSON and HENRY WOODALL for Improvements relating to Securing the Ends of Service Pipes to Mains, bearing date 18th September, 1908, and numbered 19428 of 1908,

and

IN THE MATTER OF THE PATENTS AND DESIGNS ACTS, 1907 and 1919.

Notice is Hereby Given that

BERNARD ROBERT PARKINSON, late of Restholme, Albany Road, Leighton Buzzard, in the County of Bedford, but now of 23, Westbury Road, North Finchley, Middlesex, Gas Engineer (the registered proprietor of the above-mentioned Letters Patent), and J. STONE & COMPANY, LIMITED, whose registered office is at Arklow Road, Deptford, in the County of London (the Licensees for the manufacture and sale of the inventions referred to in the said Letters Patent), have by Originating Summons dated 3rd October, 1923, applied for an Order that the term of the said Letters Patent may be extended for five years or for such other term as the Court shall think fit. AND NOTICE IS HEREBY GIVEN that on Tuesday, the 11th day of December, 1923, application will be made to The Hon. Mr. Justice Astbury at the Royal Courts of Justice, Strand, London, that a day may be fixed before which the said Summons shall not be in the paper for hearing, AND NOTICE IS HEREBY GIVEN that any person desirous of being heard in opposition to the said Summons shall at least seven days before the said 11th day of December, 1923, lodge notice of such opposition at the Chambers of the Judge, Room 165, Royal Courts of Justice, Strand, London, and serve a copy thereof upon the Applicants.

Dated this 8th day of November, 1923.
GEORGE DELOE ELLIS,
70 & 72, Chancery Lane, London, W.C.2.
Solicitor for the above-named Applicants on whom all documents requiring service may be served. C 132

What to Do with Our Boys.

Thousands of boys pass out yearly from our Elementary Schools and the Middle Forms of our Public and Secondary Schools. The Polytechnic Preliminary Technical School, conjointly with the Schools of Architecture and Engineering, provides a COMPLETE COURSE of PREPARATION for boys to enter one of the following as a career:

ARCHITECTURE, MECHANICAL AND ELECTRICAL ENGINEERING, BUILDING AND OTHER ALLIED BRANCHES OF ARCHITECTURE AND ENGINEERING.

PROSPECTUS FREE on application to—

THE DIRECTOR OF EDUCATION,
The Polytechnic,
309, Regent Street, W.1. C 164

Correspondence Courses for

Inst.Civil Engrs., Inst.Mech.E., London Univ. (Matric., Inter., B.Sc.), and All ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M.Inst.C.E., M.R.S.I., F.R.S.A., etc., Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to 8/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN STREET, LIVERPOOL. 1295

Engineering Salesmanship

and SALES MANAGEMENT.—Write for brochure describing our special Course of training for posts of unlimited scope in this lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 333, Oxford Road, Manchester. 1723

Engineering Examinations.—

Day, Evening or Correspondence Courses of Preparation for all examinations. Thousands of successes during the past eighteen years.—G. P. KNOWLES, M.B.E., B.Sc., A.M.I.C.E., etc., 39, Victoria Street, Westminster, S.W.1. C 188

TENDERS.

The Director-General.

India, Store Department, Branch No. 16, Belvedere Road, Lambeth, S.E.1, REQUIRES:—

MILD STEEL PIPES, Lapwelded.

Tenders due on the 30th November, 1923.
Tender forms obtainable from above. C 172

THE FLEETWOOD URBAN DISTRICT COUNCIL invite

Tenders for the Building of a

TWIN-SCREW FERRY STEAMER (Composite Hull).

Plans, Specification, Contract Conditions and Form of Tender may be obtained from the undersigned on payment of Two Guineas, which will be refunded on receipt of a *bona fide* Tender.

The lowest or any Tender not necessarily accepted, and no Tender will be considered unless made on the Official Form.

Sealed Tenders, endorsed "Tender for Ferry Steamer," to be delivered at the Town Hall, Fleetwood, not later than Noon on the 8th December, 1923.

By Order of the Council,
A. COTTAM,
Clerk to the Council.

Town Hall, Fleetwood,
12th November, 1923. C 147

THE COMMISSIONERS OF HIS MAJESTY'S WORKS, etc., are prepared to receive

Tenders before Eleven

a.m. on Wednesday, the 28th November, 1923, for the SUPPLY of VALVES.

Forms of Tender, etc., may be obtained on application to the CONTROLLER OF SUPPLIES, H.M. Office of Works, etc., King Charles Street, Westminster, London, S.W.1. C 129

FOR SALE BY TENDER. November 21st, 1923.

By Order of N. W. WILD, Esq., Receiver for Debenture Holders.

Tenders are now Invited

for the ASSETS of the
LONDON FOUNDRY COMPANY LIMITED.
BRIMSDOWN, MIDDLESEX,

comprising the

VALUABLE FREEHOLD LAND (about 23¾ acres)

and the

EXCELLENT FOUNDRY BUILDINGS
with an area of
53,800 sq. ft.

THE FOUNDRY is equipped with up-to-date appliances including two 10-TON CRANES, three ELECTRIC FURNACES, Core Ovens, Sand Blast Plant, Bench Saws, Lathes, Electric Motors, Laboratory, and Testing Machine, etc. for an output of

200 Tons of Steel Castings per week.

Particulars, Plans, and Conditions of Sale

from

PHILIP LAKE & CO., 66, Victoria Street, London, S.W.1,

or

FORBES & SONS, Solicitors, 19, Mark Lane, E.C.3.

FRANKLIN, WILD & Co., Chartered Accountants, Orient House, New Broad St., E.C.2.

C 102

CITY OF LIVERPOOL.

TRAMWAY MATERIAL.

The Corporation are prepared to receive

Tenders for the Supply and

DELIVERY of various classes of TRAMWAY MATERIAL, as under.

Firms are required to state clearly when making application for the necessary Tender Forms, the name and number of the Schedule for which they desire to be furnished with Tender Form.

Duplicate Forms of Tender for record purposes will NOT be supplied.

Schedule No. 1. Steel Tramway Rails and Fishplates.
" No. 2. Steel Fishbolts.
" No. 3. Steel Tiebars.
" No. 4. Copper Bonds.
" No. 5. Timber Sleepers.
" No. 6. Steel Spikes.

Tender Forms will be forwarded UPON RECEIPT OF APPLICATION IN WRITING to:—
THE CITY ENGINEER,
Municipal Buildings, Dale Street, Liverpool.

Latest Date for Receipt of Tenders:—
Ten o'clock a.m. on Friday, the 23rd instant.
WALTER MOON,
Town Clerk.

7th November, 1923. C 119

GREAT SOUTHERN & WESTERN RAILWAY (IRELAND).
CONTRACTS, 1924.

The Directors of the Great Southern and Western Railway Company are prepared to receive

Tenders for the Supply of the

undermentioned STORES for Three Months commencing 1st January, 1924, and alternatively for Six Months commencing the same date.

	No. of Form.		No. of Form.
Acid, Sulphuric ...	3D	Glass, Sheet, and Plate	27A
Asbestos Sheeting, etc.	40	Glass and China Sundries	27B
Baskets	10	Hardware (Sundry)	17
Bolts, Nuts and Rivets	15	India Rubber Goods	9A
Brooms and Brushes	13	Implements, Sundry	21
Brass Fittings for Carriages... ...	18	Iron Tubes and Fittings	29
Do. do. for Water	26A	Leather and Leather Goods	12
Do. do. for Gas ...	26B	Locks and Keys ...	19
Canvas and Sacks ...	6	Mats, Fibre	10
Canvas for Wagon Tarpaulins	6A	Nails	31
Castings, Mall. Iron	11	Packings	40
Carriage Laces ...	7A	Plumbago	41
Cloth for Carriages	7C	Rain Water Pipes and Gutters	25
Clothing, I.R., proofed	9B	Ropes, Twine & Flax	4
Coach Screws and Washers	15	Soaps	3C
Colours	2	Sewer Pipes, Plaster of Paris, etc. ...	32
Corks	39	Shovels, Spades, etc.	21A
Cotton Waste ...	5A	Sponge Cloths ...	5
Crucibles	41	Signal Wire Pulleys	11
Drysalteries	3	Screws and Split Pins	14
Emery and Glass Cloth, etc.	28	Tin Plates	22
Files and Tool Steel	20	Waste	5A
Fire Bricks and Clay	33	Waterproof Clothing	9B
Foundry Requisites	42	Wicks	5
Galvanized Sheets, Buckets, etc. ...	23	Wire, Fence and Signal	30A
Grates, Stoves ...	24	Wirework	30B
Grindstones	26		

Forms of Tender can be obtained on PAYMENT of 6d. each from the STORES SUPERINTENDENT, GENERAL STORES DEPARTMENT, G.S. & W.R., INCHICORE, DUBLIN. Applications for forms by Post must be accompanied by Postal Order. Stamps cannot be accepted. All enquiries for information should be also directed to the Stores Superintendent.

Patterns may be inspected at the General Stores Department on and after the 16th inst., between the hours of Ten a.m. and Four p.m. (except on Saturdays).

Tenders must be enclosed in the special envelope supplied for the purpose with each schedule, and must be posted so as to be with the undersigned before Ten a.m. on Wednesday, 28th November, 1923.

The Directors will not consider any Tender unless it is furnished on the Company's Form, and do not bind themselves to accept the lowest or any Tender. By Order,

C. B. RILEY, Secretary.

Kingsbridge Terminus, Dublin,
November, 1923. C 133

ADMINISTRATIVE COUNTY OF LONDON.

The London County Council invites

Tenders for a 10-Ton Hand-

operated OVERHEAD TRAVELLER, of 34 ft. 6 in. span, for the Isle of Dogs Pumping Station, London, E.

Persons desiring to submit Tenders may obtain the drawing, specification, form of tender, etc., on application to the Chief Engineer, at the Old County Hall, Spring Gardens, Charing Cross, S.W.1, upon payment of the sum of £2. This amount will be returnable only if the Tenderer shall have sent in a *bona fide* Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the drawing, specification and other contract documents may be inspected at the old County Hall before payment of the fee.

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E.1, after Four p.m., on Monday, 3rd December, 1923, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
Clerk of the London County Council. C 165

MACCLESFIELD CORPORATION.

TRENTABANK WATER SCHEME.

CONTRACT No. 1—CAST-IRON PIPES.

The Macclesfield Corporation are prepared to receive

Tenders from Experienced

Pipe Founders for the SUPPLY and DELIVERY of about 1130 tons of CAST-IRON PIPES and SPECIALS, of 18-in., 15-in., 12-in., 6-in., and 3-in. diameters, manufactured in accordance with the British Standard Specification.

The Specification and Form of Tender, prepared by Dr. H. LAPWORTH, M.Inst.C.E., 15, Victoria Street, Westminster, S.W.1, Engineer, may be obtained from the undersigned upon payment of a deposit of £2. The amount of the deposit will be returned only after the receipt of a *bona fide* Tender by the date specified and the return of the Specification.

Sealed Tenders, marked "Contract No. 1 Tender for Cast-Iron Pipes," and addressed to the undersigned, must be delivered not later than Ten a.m. on the 28th day of November, 1923.

The Corporation do not bind themselves to accept the lowest or any Tender.

F. R. OLDFIELD,
Town Clerk.

41, Churchside, Macclesfield,
9th November, 1923. C 136

BOARD OF GUARDIANS,
ST. MARYLEBONE.

TO HEATING ENGINEERS.

Tenders are Invited for Work

in connection with the ALTERATION and ADDITION to the HEATING SYSTEM at the Guardians' Offices, Northumberland Street, W.1. Specification and form of Tender may be obtained on application to Messrs. CONSTANTINE AND VERNON, Architects, 82, Mortimer Street, W.1, where the Conditions of Contract may be seen between the hours of TEN a.m. and FIVE p.m. on the 20th, 21st and 22nd November, on depositing with that firm of Architects a £1 Treasury Note, which will be returned on receipt of a *bona fide* Tender. Tenders to be delivered in sealed envelope endorsed "Tender for alteration and addition to heating system, Guardians' Offices," to me, at my office, Northumberland Street, W.1, not later than Saturday the 1st December. Any of the items may be eliminated from the Contract at the discretion of the Guardians and the Board does not undertake to accept the lowest or any tender.

By Order,
EDWARD A. FRITH,
Clerk to the Guardians.

Guardians' Offices,
Northumberland Street, W.
November, 1923. C 143

Tenders are Invited for the

PURCHASE of SECOND-HAND PUMPING MACHINERY for Disposal at No. 6 Pumping Station, Southampton Docks.

Two 48 in. "Invincible" Centrifugal Dry Dock Pumps, each driven by a twin high pressure cylinders steam engine. Cylinders 28 in. bore, 18 in. stroke. Approx. HP. 1000 at 140 revs. and 150 lbs. steam pressure.
Average pump capacity, 400 tons per minute at a gauge head 0-40 ft.

One 45 in. "Invincible" Centrifugal Dry Dock Pump driven by a Compound steam engine. Cylinders, 16½ in. by 33 in. bore, 18 in. stroke. Approx. B.HP. 350 at 150 revs. and 150 lbs. steam pressure.
Average pump capacity, 200 tons per minute at a gauge head 0-15 ft.

One 9 in. "Invincible" Centrifugal Circulating Water Pump, driven by a single cylinder steam engine, steam pressure 180 lbs.

Two Compound steam driven "Edwards" Air Pumps, pump chamber 18 in. by 10 in., revs. 400 per minute.

One Cylindrical Surface Condenser, 13 ft. by 5 ft. by 3 ins.

One Cylindrical Surface Condenser, 14 ft. 3 in. by 5 ft. 6 in.

One Wrought Steel Steam Range for 160 lbs. working pressure, recently installed, comprising:—
36 ft. of 9 in. straight.
18 ft. of 9 in. straight with 6 in. branch.
One 9 in. bend, 6 ft. 9 in. by 12 ft. 0 in.
One 9 in. bend 16 ft. 4 in. by 8 ft. 0 in.
One 9 in. bend 8 ft. 0 in. by 8 ft. 9 in.
One 9 in. by 8 in. by 8 in. steam separators.

Small Quantity of 9 in. Pipe and Sundry Valves, Cocks, Steam Traps, Supports, etc.

A quantity of Cast-iron Flanged Piping as follows:—

Approx.	26 feet of	20	inches.
"	65 "	14	"
"	170 "	9	"
"	60 "	6	"
"	85 "	4	"
"	40 "	3	"

A quantity of Cast-iron Gate Valves as follows:—
1-26 inches.
4-14 "
12-9 "
2-6 "

Sundry Smaller Valves and Fittings.

Full particulars can be obtained from C. FRANCIS, Esq., Stores Superintendent, Southern Railway, Waterloo Station, S.E.1. C 166

EAST INDIAN RAILWAY.

The Directors are prepared to receive up to Eleven a.m. on Wednesday, the 28th instant,

Tenders for the Supply of:—

WROUGHT IRON PIPING.

Copies of the specification can be obtained at the Company's Offices on payment of £1 1s. each. This fee will not be returned.

G. R. LILLIE,
Secretary.

73/6, King William Street, London, E.C.4.
15th November, 1923. C 170

INCE-IN-MAKERFIELD URBAN DISTRICT COUNCIL.

The Urban District Council of Ince-in-Makerfield invite

Tenders for:—

DIESEL OIL ENGINE, driving Bore Hole and Horizontal Pumping Sets, in duplicate.

Specification and Particulars of Tender may be had from the undersigned on payment of a sum of £2 2s., which will be returned on a *bona fide* Tender being received.

Sealed Tenders, endorsed "Tender for Waterworks Plant," must reach the undersigned not later than Ten a.m., November 30th, 1923.

The Council do not bind themselves to accept the lowest or any Tender.

A. F. HOWGATE,
Clerk.

Council Offices,
Ince, near Wigan. C 167

BENGAL-NAGPUR RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive

Tenders for:—

(1) WROUGHT IRON, etc., FITTINGS for Carriages.
(2) GUNMETAL LAVATORY and other FITTINGS for Carriages.
(3) INDIA RUBBER, etc., FITTINGS for Carriages.

Specifications and Forms of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad Street, London, E.C., on or after 19th November, 1923.

A fee of £1 1s. will be charged for Specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Monday, 26th November, 1923.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
R. C. VOLKERS,
Secretary. C 141

ADMINISTRATIVE COUNTY OF LONDON.

LEWISHAM BRANCH SEWER.

The London County Council invites

Tenders for the Construction

of a BRICK SEWER of varying sizes, from 5 ft. to 9 ft. Internal diameter, of a total length of about 3 miles, with Weir Chambers, Tumbling Bays, Drop Shafts, Side Entrances and Connections to Existing Sewers, etc., in the Metropolitan Borough of Lewisham.

Persons desiring to submit Tenders may obtain on and after Friday, 16th November, 1923, the Form of Tender, etc., on application to the Chief Engineer at the Old County Hall, Spring Gardens, S.W.1, upon payment of the sum of £10. This amount will be returnable only if the Tenderer shall have sent in a *bona fide* Tender, and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before the payment of the fee.

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E.1, after Twelve Noon on Tuesday, 11th December, 1923, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
Clerk of the London County Council. C 136

PORT OF BRISTOL.

CONSTRUCTION OF EASTERN ARM OF ROYAL EDWARD DOCK.

PRELIMINARY NOTICE.

The Docks Committee expect to shortly invite

Tenders for the Construction

of the EASTERN ARM of the ROYAL EDWARD DOCK, Avonmouth.

The work will consist principally of the Removal and Carrying to Spoil of the Main Excavation for the Arm of the Dock, together with the construction of a ferro-concrete built Wharf about 1700 ft. long on each side. Also the construction of two three-floor ferro-concrete built Transit Sheds, each 500 ft. long; and a ferro-concrete built Silo Granary of about 6000 tons capacity.

The complete Plans and Specification will be ready early in December, but in order to provide employment at the earliest possible date it will be necessary that the Tenders should be received early in January. This preliminary notice is, therefore, issued so that intending Tenderers may make an inspection of the site as soon as possible after Monday, 12th November, when they can obtain such of the Drawings and Schedules of Prices as may be ready at the time.

The complete Specification, Schedules of Prices and Contract Drawings, will be sent early in December to all applicants on production of a receipt showing that a deposit of £15 has been paid to the Bristol Docks Committee, 19, Queen Square, Bristol, to whom all cheques must be made payable. The deposit of £15 will be returned hereafter to all *bona fide* Tenderers.

Communications for an inspection of the site, etc., should be sent to the undersigned as early as possible.

The Docks Committee do not bind themselves to accept the lowest or any Tender.

THOMAS A. PEACE,
Chief Engineer,
Port of Bristol.

Chief Engineer's Office,
Avonmouth Docks,
31st October, 1923. C 128

1923.

THE USEFUL LIFE OF AMERICAN LOCOMOTIVES.

By Lawford H. Fry, M.Inst.C.E.

It is a European tradition of long-standing that in the United States locomotives are designed and built for a short intensive life and early relegation to the scrap heap. At first sight there seems to be some truth in the idea as the great increases made in the power of locomotives in recent years have caused the older engines to be retired from the heavy main line services. Closer examination shows, however, that though the economic life may be shortened by the introduction of more modern power units there is no evidence of a conscious aim at a short mechanical life.

The present study is an attempt to collect and set forth the facts as to the life and service of locomotives in the United States. Through the courtesy of the officials of a number of the larger railroads a considerable amount of exact information has been made available. Among those contributing data are the roads shown in Table I. This table gives

Table I.—*Railroads Contributing Information regarding Useful Life of Locomotives.*

—	Miles.	Locomotives.
Baltimore and Ohio Railroad System	5,230	2,672
Philadelphia and Reading Railway Company	1,127	1,105
Chicago, Burlington and Quincy Railroad Company	9,394	1,950
Atlantic Coast Line Railroad Company	4,856	890
Norfolk and Western Railway Company	2,238	1,070
Lehigh Valley Railroad Company	1,335	1,018
Seaboard Air Line Railway Company	3,563	606
Union Pacific System	9,450	1,883
Chicago, Milwaukee and St. Paul Railway Company	11,030	2,045
Louisville and Nashville Railroad Company	5,089	1,306
Illinois Central Railroad Company	4,799	1,671
Atchison, Topeka and Santa Fé Railway System	8,862	2,159
Chicago and North-western Railway Company	8,404	2,087
Chicago, Rock Island and Pacific Railway Company	8,123	1,633
Pennsylvania Railroad System	10,534	7,447
Southern Pacific Company	7,118	1,507
Union Railroad Company	46	161
Duluth, South Shore and Atlantic	594	74
Totals	101,742	31,284

the mileage and present number of locomotives operated by each company. It may be noted that the railroads listed own approximately half of the locomotives belonging to the Class I* American railroads, 31,284 out of a total of 75,962 locomotives, so that there can be no question as to the adequacy of the data considered. The general conclusions to be drawn from these data can be stated very briefly. The locomotives being retired from service at the present time have an average age of rather more than thirty years, and retirement is due to obsolescence of the type and not to physical deterioration of the machine. The railroad officials are unanimous in reporting that the engines now being retired could have been kept in service practically indefinitely if the continually increasing demands of the traffic, and the greater power of the modern locomotive had not made the older engines inadequate for the service and comparatively uneconomical to operate.

The necessity for retiring the older locomotives becomes apparent when the growth in size of locomotives is considered. Table II shows the approxi-

Table II.—*Average Maximum Weight of Various Locomotive Types at Different Periods.*

Year.	Passenger Types.			Freight Types.	
	4-4-0	4-4-2	4-6-2	2-8-0	2-8-2
1870	66,000	—	—	90,000	—
1880	72,000	—	—	100,000	—
1890	88,000	—	—	120,000	—
1900	112,000	160,000	—	178,000	—
1910	—	200,000	250,000	230,000	250,000
1920	—	—	280,000	250,000	320,000

Year each type first introduced into American main-line service:—1840, 1894, 1903, 1886, 1903.

mate maximum weight (locomotive in working order without tender) of various important types of locomotives for the last fifty years. In the year 1870 the two important types were the 4-4-0 and the 2-8-0, the former handling the bulk of the passenger traffic and the latter all the heavier freight. The maximum weights of these engines at that date were approximately 66,000 lb. (29·5 tons) for the 4-4-0 and 90,000 lb. (40 tons) for the 2-8-0. By 1880 these maximum weights had risen to approximately 72,000 lb. (32 tons) for the 4-4-0 and 100,000 lb. (45 tons) for the 2-8-0. In 1890 the heaviest 4-4-0 weighed approximately 88,000 lb. (39 tons) and the heaviest 2-8-0 approximately 120,000 lb. (54 tons). A decade later in 1900 the maximum weight of the 4-4-0 had increased approximately 27 per cent. to 112,000 lb. (50 tons) and the 4-4-2 or "Atlantic" type had been introduced giving a weight of 160,000 lb. (72 tons), an increase of more than 80 per cent. in the ten years. In another ten years, 1910, the 4-4-0 had practically ceased being built for first-class main line service and the weight of the "Atlantic" type had gone up to 200,000 lb. (90 tons), an increase of 25 per cent. in the ten years. By this time the "Pacific," or 4-6-2 type had come into use with a maximum weight of 250,000 lb. (112 tons). The next ten years, ending 1920, saw the "Atlantic" type superseded and the "Pacific" type with a weight of 280,000 lb. (125 tons) established as the standard heavy passenger engine.

In freight service the story is similar. The consolidation or 2-8-0 type increased in weight from 20 per cent. to 30 per cent. every ten years, reaching 230,000 lb. (103 tons) by 1910. By that year the "Mikado," or 2-8-2 type, had come into service, and showed a maximum weight of approximately 250,000 lb. (112 tons). The ten years to 1920 increased this weight approximately 28 per cent. to 320,000 lb. (142 tons). To sum up the foregoing the heavy passenger engine grew from 88,000 lb. (39 tons) in 1890 to 280,000 lb. (125 tons) in 1920, while the heavy freight engine grew from 120,000 lb. (54 tons) in 1890 to 320,000 lb. (142 tons) in 1920. In the thirty years the weight of passenger engines had increased in the proportion of about 3·2 to 1, and that of freight engines in the proportion of about 2·8 to 1.

This account of growth in locomotive power is intentionally brief and cursory, and covers only one phase in the development of railroad equipment. Freight and passenger cars have increased in capacity, and bridges and permanent way have been strengthened to carry the heavier axle loads. The rail loads for locomotives have increased from approximately 30,000 lb. (13·5 tons) in 1890 to about 68,000 lb. (30 tons) in 1920. It is not to be doubted that there will be growth and development in locomotive power in the future, but the rate of growth is slowing down as it approaches definite physical limitations which cannot be exceeded. For example, no great increase can be made in rail loads without encountering difficulty from the crushing of rail and tyre steel at the point of contact. The area of contact between rail and wheel on which the rail load is carried is fixed by the wheel diameter in which no increase can be expected. Driving axle loads have been brought up to 68,000–70,000 lb., which means 34,000 lb. to 35,000 lb. (15 tons to 15·5 tons) per wheel at the rail at rest. With the area of contact fixed the present load cannot be increased to any great extent without producing a flow of the steel and permanent injury to tyre or rail. It may be argued that with the present axle loadings increase in power can be obtained by increasing the number of coupled axles, as, for example, by putting 4-8-2 "Mountain" type engines into passenger service in place of the present 4-6-2 "Pacific" type and 2-10-2 "Santa Fe" type into freight service to replace the present 2-8-2 Mikados, or by the use of "Mallet" articulated locomotives. The indications are, however, that, for the near future at least, the "Mountain" and "Santa Fe" types will be used only on divisions with the heavier grades leaving the "Pacific" and "Mikado" types as the standard types for road service.

Car design will have a retarding influence on locomotive growth in the next few years. Mr. Sillcox, general superintendent of motive power of the Chicago, Milwaukee and St. Paul Railway, points out that advances in design and strength of materials in cars have not kept pace with the advances made in design and power of locomotives, and that before any great increase is made in locomotive tractive power it will be necessary to have the strength of draft rigging and car underframes increased. This involves development of new designs and a large investment of capital. As the rate of increase in locomotive growth slows down the tendency to eliminate existing engines to secure economies by the introduction of larger units will be reduced, and it is safe to say that unless revolutionary and unforeseen changes in design are introduced, the growth in power of steam locomotives will be much slower in the future than it has been in the past twenty years. This means a postponement of obsolescence and an increase in the economic life for the engines of the decade just past and of that to come, when compared with the engines of twenty years ago.

Coming now to statistics of the actual economic life, Table III is presented. This has been prepared

Table III.—*Average Age of Locomotives Dismantled or Recommended for Dismantling.*

Road.	Year.	No. of Locos.	Average Age.
P.R.R.	1922	234	29·4
C.M. and St. P.	1918 to 1920	208	35·5
B. and O.	—	495	29·9
A.T. and S.F.	1922	59	33·3
U.P. R.R.	1909 to 1923	—	28·7
S.A.L.	1923	18	30·0
C.B. and Q.	1922	26	35·5

from figures furnished by seven railroads which own a total of 18,762 locomotives. The table shows the average age of the locomotives dismantled, or recommended for dismantling, by these roads in 1922 or adjacent years. It will be seen the average retiring age of the locomotives becoming obsolete at the present time varies from 28·7 to 35·5 years. The officials of the various railroads are, as stated above, unanimous in saying that retirement is not due to the locomotives being worn out, but to obsolescence caused by the introduction of heavier and more modern engines. Obsolescence on this account will vary from one road to another according to the class and conditions of traffic to be handled. On a road having a predominance of heavy through traffic the necessity for the economies to be secured by heavy engines will push the older locomotives out at a comparatively early age. On the other hand, where lighter branch line traffic forms a considerable proportion of the business it will offer a sphere of prolonged usefulness for the lighter engines displaced from the main line service.

An example of this latter condition is given by the Louisville and Nashville Railroad. The latest engine summary of this company shows 1,306 locomotives on hand, of which 238, or 25 per cent., have given 30 years' service or over. Of these 88 have been in service over forty years, and 20 have been in service over fifty years, the oldest having been built in 1870. Mr. C. F. Giles, superintendent of machinery, in giving this information, says that the question of the useful life of locomotives has been given considerable attention in the last ten or fifteen years from the point of view of accountancy. The estimated life was originally set at thirty-three years, but it has been necessary to revise the depreciation schedules on several occasions by reason of many of the engines having outlived that period. An interesting example of the prolongation of life by transfer of service, is given by a series of 4-4-0 type locomotives retired from service on one of the leading railroads in the Eastern States a few years ago. The incident also illustrates the effect of proper repairs on the mechanical life of a locomotive. A series of 4-4-0 engines was being gradually replaced in main line service after about twenty-five years' service by 4-4-2 "Atlantic" types, and on retirement the locomotives were sold at the scrap value of 3,000 dols. to a subsidiary branch road. The service being light, the engines were entirely satisfactory, but in view of their low purchase price they were scrapped outright when, after a few years, general repairs became necessary and other similar old engines were purchased. This continued until the source of supply of old engines drew near exhaustion. Then the branch road, before putting the old engines into service, gave them a thorough overhauling at a cost of 10,000 dols. and found that if running repairs

* Class I. railroads are those having annual gross operating revenues in excess of one million dollars.

were kept up the engines could remain in service indefinitely. The engines had become obsolete for main line service after twenty-five years, because train weights had grown beyond their capacity, but on being put into service such as that for which they were originally designed, they were able, when properly kept up to continue in service indefinitely.

The records of the Philadelphia and Reading Railway Company show that out of 1,105 locomotives 253 have been in service twenty-four years or longer, with 76 in service thirty-four years or longer. The oldest engines still working are a series of 32 consolidations or 2-8-0 type with 20-in. cylinders, which were built by the Baldwin Locomotive Works in January, 1882, and are therefore over forty-one years old. On the older engines the boilers have been renewed once or even twice. The records show that on the 253 engines referred to above there are 125 boilers with twenty-three years or more of service and 34 boilers with thirty years or more.

Owing to the amount of attention which has been given to the valuation of railroad properties by Congress in the last fifteen years, a great deal of information has been collected by the railroads and by the Interstate Commerce Commission, with a view to ascertaining the life expectancy of locomotives. In 1916 the Division of Valuation for the Western District of the Commission made an elaborate actuarial study of the life history of over 8,000 locomotives. The locomotives were owned by the nine representative railroads in the central western States, shown in the following list:—

Name of Railroad.	No. of Engines.
Atchison, Topeka and Santa Fé	2,612
Chicago, Rock Island and Pacific	2,115
Kansas City Southern	260
International and Great Northern	231
Wisconsin Central	285
Minneapolis, St. Paul and Saulte Ste. Marie ..	332
San Antonia and Arkansas Pass.	125
Great Northern	1,450
Missouri, Kansas and Texas	755
	8,165

The periods in which the locomotives were built and the disposition made of them up to June, 1915 are shown in Table IV.

It should be noted that locomotives which received new boilers were withdrawn from further consideration, so that the number of engines shown as remaining in service at the end of the period studied is less than would be shown by the usual method of consideration, where the application of a new boiler would be taken as extending the life instead of terminating it.

The complete data of the lives of the 8,000 locomotives was subject to thorough analysis with the results shown in Fig. 1. Here the expectancy of life at each age is shown for each of the three age-groups by broken lines while the solid line shows the corrected expectancy of all groups. This last line was obtained by applying the elaborate mathematical methods of life insurance actuaries to the complete locomotive data. The earlier locomotives have a shorter expectancy due to their poorer showing under the ever-increasing weight of trains. When all age-groups are taken together the total life to be expected increases with each succeeding year. Beginning with approximately thirty years, it ends at forty-five years. In considering these results it should be borne in mind that they represent the life expectancy of locomotives under the conditions obtaining in the thirty-six years from 1879 to 1915 extrapolated to give an expectancy of forty-five years for the longest lived engines. The conclusions are unquestionably accurate for the

Fig. 1. CHART SHOWING EXPECTANCY OF LIFE FOR LOCOMOTIVES AT EACH AGE.

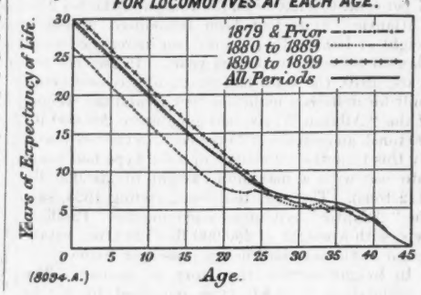


TABLE IV.—*Particulars of Locomotives Collected by Interstate Commerce Commission.*

Period.	1. Total No. of Locomotives.	2. No. Sold.	3. No. Receiving New Boilers.	4. No. Abandoned.	5. No. Remaining in Service June, 1915.
1879 and prior	575	67	98	387	23
1880–1889 ..	1,699	223	107	542	827
1890–1899 ..	1,342	62	14	80	1,186
1900–June 30, 1915 ..	4,549	37	19	1	4,492
Total ..	8,165	389	238	1,010	6,528

locomotives dealt with and the period considered. It must be remembered, however, that the retirement of the locomotives was due to obsolescence, brought about by the developments made in railroad practice during the period in question. Now the life expectancy found, will not hold for the future unless the developments producing obsolescence continue along the same lines as they have done in the past, but, as has been shown above, it is improbable that this will be the case. It is reasonable to suppose that the inevitable slowing down of locomotive growth in the near future will retard obsolescence, and that therefore the locomotives put in service in the recent past and in the near future will have a greater expectancy of life than did their predecessors.

It may be noted here that it has been proposed in valuing the railroads to use a life expectancy table as given above to calculate the depreciation in value that the locomotives of various ages have undergone. This procedure is, however, widely opposed by motive power officials, who argue that when proper running repairs are made as is necessary, and charged to operating account, the locomotive can be maintained continuously in the same service, and that it therefore retains its full original earning capacity, and should not be subjected to depreciation. The point is well covered by testimony given before the Interstate Commerce Commission in June, 1917, by Mr. D. F. Crawford, then general superintendent of motive power of the Pennsylvania Lines West of Pittsburgh.

Returning to simpler statements of age, Table V has been complied to show the average age of locomotives in service on the Southern Pacific. The average of all of the 1,516 locomotives is 17·3 years, which includes 481 locomotives over twenty years of age which average 23·8 years. The oldest group comprises 28 4-4-0 type engines in branch line service with an average age of 35·2 years. Table VI gives information regarding a number of typical locomotives on the Chicago and North-western Railway. Five representative classes of freight and the same number of classes of passenger engines are shown, with the date on which the first engine of each class was put into service and the mileage record of each of these first engines. With one exception, all of the engines shown were still in service in January, 1923. The oldest engine, which is still running, shows a mileage of over 1,350,000 miles in forty-three years' service.

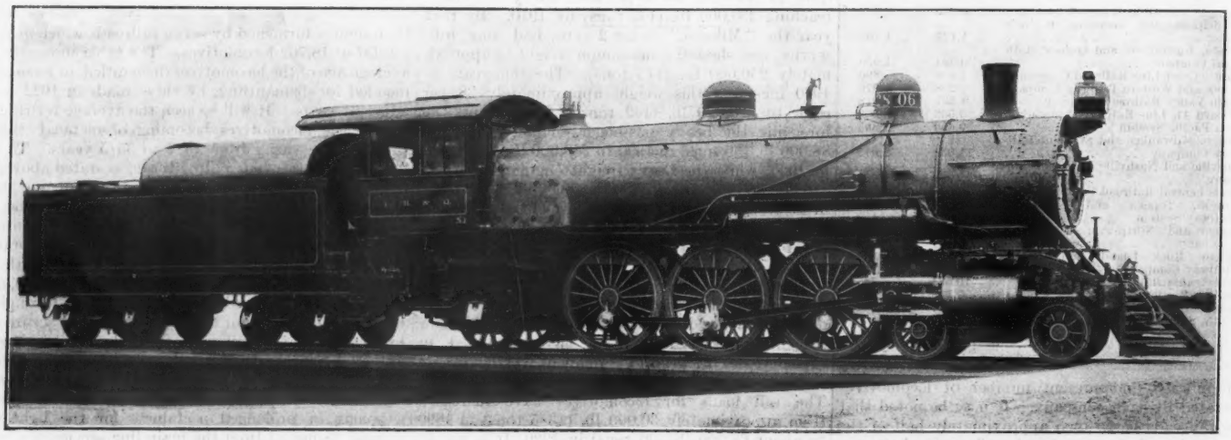


FIG. 2. BALDWIN "PACIFIC" TYPE LOCOMOTIVE WITH A RECORD OF 1,323,315 MILES IN SIXTEEN YEARS.

In connection with the age of locomotives it is of interest to consider the mileage accomplished. Complete information on this subject is not readily available on all roads, but the following figures give a good general oversight of the situation. The Chicago, Burlington and Quincy Railroad gives particulars for two representative locomotives, still in service, selected at random. Engine No. 641 in suburban work out of Chicago, 4-6-0 type, with 19-in. and 24-in. cylinders, built by Rogers Locomotives Works in 1892, has a recorded mileage of 794,000 miles for the twenty-three years from 1900 to 1923, and in the absence of earlier records its total mileage in thirty-one years is estimated as at least 1,071,000 miles. Engine No. 2,820, 4-6-2, or "Pacific" type, built by the Baldwin Locomotive Works, has a recorded mileage of 1,323,315 miles in sixteen years, and as it is good for at least ten years further in the same service a total mileage of well over 2,100,000 miles is looked for. A sister engine of the same series is shown in Fig. 2.

On the Atlantic Coast Line Railroad engine No. 26, a 4-4-0 type with cylinders 18 in. by 24 in., built by Baldwin Locomotive Works, in 1888, and now in branch-line passenger service, made 551,000 miles in the eighteen years, 1905 to 1923. On this basis the total mileage in the thirty-five years of service is over 1,000,000 miles. Engine No. 89, 4-4-2, with cylinders 19 in. by 24 in., built in 1894 by the Baldwin Locomotive Works, and illustrated in Fig. 3, on page 624, was one of the earliest

"Atlantic" type locomotives built, in fact, one of the original series of engines which gave the name "Atlantic" to the 4–4–2 type. In twenty-one years, 1902 to 1923, this engine made 577,675 miles, with a probable present total of over 800,000 miles. It is still fully up to the present service. Chicago Rock Island and Pacific Railway engine No. 605, a 4-4-0 type with cylinders 18 in. by 24 in., built in 1890, has a recorded mileage in the twenty-two years, from 1900 to 1922 inclusive, of 926,051 miles, giving an estimated mileage in its past thirty-three years of service of over 1,400,000 miles. The engine is still in regular service, and will probably give 1,500,000–1,750,000 miles before being retired.

For the Duluth South Shore and Atlantic Railway Company engine No. 104, a 4-4-0 type, with cylinders 18 in. by 24 in., built by the Baldwin Locomotive Works, in 1888, complete records are available showing yearly mileages ranging from 19,748 in 1900 to 97,121 in 1904, and giving a total of 1,761,145 miles up to March 1, 1923. Mr. Herron, superintendent of motive power writes: "This engine still has the original boiler shell, wrapper sheet, back head, engine frames, &c. The boiler shell is practically as good as new and we expect to keep her in light passenger service for a number of years."

In industrial service the results are similar to those already recorded. Two subsidiaries of the United States Steel Corporation give the following mileage figures for switching service in the Pittsburgh district: Union Railroad Company engine No. 4, a four-wheel switcher with cylinders 17 in. by 24 in., built by the Pittsburgh Locomotive Works, was put in service in 1881 and retired in 1921. Actual figures snow that this engine worked 245 24-hour days in each of the last seven years of its life, with an average of 6 miles per hour. On this basis the total mileage would be over 1,400,000 miles in the forty years of its life. National Tube Company engine No. 11, a six-wheel switcher with cylinders 18 in. by 24 in., built in 1895, has worked 24 hours a day for approximately 320 days per year for twenty-eight years, giving an estimated mileage of over 1,290,000. The second fire-box was applied to this engine in 1920, and it is believed that the engine will give at least ten years further life in its present service. As a concluding example, the locomotive shown in Fig. 4 is cited. This real veteran was built by the Baldwin Locomotive Works in 1856. It has been in continuous operation ever since and according to the present owners. the J. N. Bray Company, Valdosta, Georgia, is still, after a life of 67 years, in good condition for the service required.

The information examined covers a wide range of locomotive practice, and is entirely concordant in showing that main line locomotives are to-day generally retired after about thirty years' service for economic reasons only and that their mechanical life could be continued for a very much longer period. There is no evidence of locomotives being designed at the outset for a short life. As a matter of fact, at the time a locomotive is built it is impossible to foretell the future developments which will determine the length of its economic life. The only safe rule is to aim at design and construction such that periodic repairs will maintain the locomotive at its original efficiency.

TABLE V.—Locomotives in Service, Southern Pacific Company (Pacific System), over Nineteen Years Old.

Number of Engines, Service and Age.

Type.	Main Line.	Average Age.	Branch Line.	Average Age.	Total.	Average Age.
4-4-0	51	31 years 8 months ..	28	35 years 2 months ..	79	32 years 11 months.
2-6-0	152	21 years 8 months ..	3	29 years 0 months ..	155	21 years 11 months.
4-6-0	51	22 years 5 months ..	7	34 years 1 month ..	58	23 years 2 months.
2-8-0	79	19 years 7 months ..	2	27 years 6 months ..	81	19 years 9 months.
4-8-0	16	27 years 6 months ..	32	31 years 7 months ..	48	30 years 3 months.
4-4-2	3	20 years 5 months ..	—	—	3	20 years 5 months.
0-6-0 Sw. ..	—	—	—	—	57	26 years 10 months.
Total	352	23 years 1 month ..	72	33 years 0 months ..	481	23 years 8 months.

Total locomotives owned as at December 31, 1922:—1,516; average age, 17 years 4 months.

Table VI.—Record of Typical Locomotives, Chicago and North-Western Railway.

Characteristics.

Class.	Builder.	Cylinder.	Pressure. lb. per sq. in.	Diameter, Drivers. in.	Tractive Power. lb.	Weight, Drivers. lb.	Weight, Engine. lb.
S–2	Schenectady ..	19 in. by 24 in. ..	170	59	21,150	101,575	129,600
R	Schenectady ..	20 in. by 26 in. ..	190	63	26,600	121,750	156,700
R–1	Schenectady ..	21 in. by 26 in. ..	200	63	30,900	126,000	162,500
Z	Schenectady ..	25 in. by 32 in. ..	170	61	47,500	209,500	238,000
J	Schenectady ..	27 in. by 32 in. ..	185	61	60,100	227,500	302,000
A–4	C. and N.W. ..	18 in. by 24 in. ..	150	62	14,300	57,800	90,900
A–5	C. and N.W. ..	17 in. by 24 in. ..	180	69	15,300	66,700	108,200
C–5	Schenectady ..	18 in. by 24 in. ..	150	63	15,700	61,900	85,300
D	Schenectady ..	20 in. by 26 in. ..	200	81	21,900	91,000	158,000
E	Schenectady ..	25 in. by 28 in. ..	185	75	36,600	154,500	250,500

Class A–5 engines had larger boilers applied in 1898–1902.

Life and Mileage.

Service.	Type.	Class.	Engine No.	Built.	Retired.	Life to January 1, 1923.	Average Miles per Month.	Total Mileage.
Freight	4-6-0	S–2	745	March, 1890 ..	—	32 years 4 months	2,452	950,978
Freight	4-6-0	R	5	Oct, 1897 ..	—	25 years 3 months	1,564	596,149
Freight	4-6-0	R–1	168	April, 1901 ..	—	21 years 9 months	2,114	552,178
Freight	2-8-0	Z	1,455	Nov., 1909 ..	—	13 years 2 months	2,069	326,866
Freight	2-8-2	J	2,301	July, 1913 ..	—	9 years 6 months	2,180	248,678
Passenger	4-4-0	A–4	274	May, 1884 ..	Dec., 1912	28 years 8 months	3,752	1,212,800
Passenger	4-4-0	A–5	248	Oct, 1879 ..	—	43 years 3 months	2,613	1,356,419
Passenger	4-4-0	C–5	687	April, 1888 ..	—	34 years 8 months	3,317	1,379,843
Passenger	4-4-2	D	1,015	July, 1900 ..	—	22 years 6 months	4,156	1,122,068
Passenger	4-6-2	E	1,500	Oct., 1909 ..	—	13 years 3 months	4,431	704,603

THE COMMERCIAL VEHICLE SECTION OF THE PARIS SALON.

Three days careful examination of the exhibits at the Grand Palais only confirmed the conclusion of one's first impressions that while the material, design, workmanship and detail ingenuity of the vehicles shown were admirable, not one in 20 could be called "a production job" even for restricted output. The inevitable outcome was that the average would-be users of automobile transport, might admire heartily enough, but literally could not afford to buy, so long as horses, with all their defects, continue to be numerous and in cheap supply. Many buyers are not interested in the elegancies of automobilism, and merely ask for adequate all-weather shelter for driver and goods. They know that every minute the auto-transport machine is idle, it is not only unprofitable, but actively losing money. They look for nothing but the essential elements for transport alone at the lowest first cost; and for that combination which appears most likely to give a reasonable degree of handiness for loading and discharge; and as much durability as possible.

As a typical example of what is offered as compared with what is needed, every fourth stand or so at the Salon contained an exhibit of the "type normande" an ostensible farmers' general-purpose car: a small 10-15 h.p. vehicle with an empty covered rearward space, while, for a land of great highways and scattered villages, leagues from a railway, that should afford scope for thousands of country carriers by auto-transport, there was not a single vehicle in the show truly equipped for the fundamental purposes of a country carriers' business.

Another important point with which this exhibition did not deal in a wholly satisfactory manner, except in rare cases—such for instance as the 12 h.p. "camionette" exhibited by E. Bernard, of Argueil (Seine)—is that of the proportion of dead vehicle weight to useful load. This 1,500 kg. (about 30 cwt.) example appeared to embody all the fundamentals of its purpose; such as amply strong springs, light chassis weight obtained by adequate design, embodying unbroken single-piece component constructions where possible, especially in the transmission—in which the best feature was a very soundly designed spur-type secondary reduction—and an unusually light frame. The construction of this last, aided by the spring arrangement, was such as to withstand all probable or even exceptional torsional stresses of road and load.

Again, so far from four-wheel braking being a general feature, as in the first section of this exhibition, it was actually somewhat rare; its examples being by far secondary to those of transmission braking. Of the few servo-braking devices, the most interesting were the not dissimilar Renault and Berliet on the one hand, and the Saurer, in which the braking power of the engine is the sole medium. As to the former, the chief feature of the design has been the slight compromise of fully enclosing the clutch, and the departure to the block transmission (a rigid unification of gear box and torque-tube, with but a single flexible joint in the whole line), of which Bianchi, Excelsior-Adex and Armstrong-Siddeley have hitherto been the chief exponents. In the two Renault commercial chassis, however, the torque tube was shortened with a yoke attached to the front of the main cross-member; therewith enclosing a transmission brake drum. Rearwardly, transmission continued in a thick tubular shaft, universally jointed and leather-muffed at each end up to a square sectioned bridge-type axle, with a final 3 to 1 planetary reduction, encased around the outer hubs of the pressed steel wheels. For the servo-brake, a short transverse stub shaft was gear driven from the lay shaft in the gear box, and—outside the inner wall of the latter, but still encased in its mass-structure—carried a drum in constant rotation, from the motor drive. This drum was surrounded by a band, connected as the intermediate braking member, with the controls of both front and rear brakes. This band grips the drum with a slight lead (the degree of which is the subject of adjustment) at the instant the connections are tightened by the application of pedal or hand lever, so that progressively, the drive from the engine, or its retarding negative compression at full throttle-choke, acts as the servo-medium. In the Berliet device, brakes shoes are substituted for the band.

The Saurer system, on the contrary, employs no extra mechanism nor connection with the mechanical braking system, but solely employs the negative compression of air combined with piston minus pressures, of the engine. This, however, is not effected in the original La Buire manner of cutting out the carburettor and admitting air, only by way of the induction, but is done by way of an end-long movement of the cam shaft, actuated from the steering wheel,

simultaneously with the complete cutting out of the carburettor.

As to final transmission arrangements, chains were in a considerable minority, though still numerous; but curiously enough, though their exponents proclaim the superior theoretical direct-line-efficiency drive, not one of them had made the least effort to preserve it in practice by enclosing the chains, not merely for oil bath lubrication, but as a protection from the wet and mud. Obviously, on the other hand, axles in all designs are naturally protected. Of these, the one-piece bridge type constructions leave nothing—apart from the unsprung-weight defect of their type—to be desired. M. Blum, of the Etablissements Latil, of Suresnes, was again this year the only exponent of transmission to all four wheels, with its more effective traction and greater tyre economy, although its alleged defect is a certain difficulty in leaving a closely-approached kerb-side. In his other geared down drive to the rear wheels of a 14 h.p. station bus chassis, by way of cardan shafting in an all-suspended transmission, he would appear to have obtained easily the best of all final-drive solutions.

The great "feature" exhibit of the show—though actually just as much existent, if unnoticed, at the Invalides any year since the war—was the "benne basculante," or tipping wagon. The arrangement deriving its hoist from some telescopic or non-telescopic oscillatory screw-jack arrangement, had but a single representative at the Salon; and where some simple cable and windlass system is not used, it had been displaced by one or more pistons operated by oil pressure, derived from either a multiple plunger or spur oil pump, actuated by sliding gear engagement with the permanent mesh-driven pinion of the gear box.

The point of rivalry between various models, however, lies not in these details, nor in the method of attachment to tip-container and chassis of the operating mechanisms, but rather in the broader issue of rearward tipping only, as against tipping backwards and upon either side. Of the latter, the "Tribenne," shown by the Société Economique Franco-Suisse, was the single protagonist. Very simply described, its body rests on steel cups, engaging four globe-headed steel posts, two each side, which afford it, theoretically, an ideal pivotal medium for tipping either side or backwards. Its pistons—of which the cylinders oscillate—are united above in a solid arch, which engages a channel segment of the arc of the tipping circle, so that the predetermined movement of the container is assured in any one of three directions by freeing one pair of posts and leaving the other pair locked.

The others, from the Renault down to some of lesser fame, had but the single facility of backward tipping, with all advantages or disabilities that may accrue therewith. But about one of them, the Wood, built both in France by its exhibitor, Fernand Geneve, and in England by the Hydraulic Hoist Company, of Southport, there can be no question on one point. That is, its ingeniously contrived ability to tip from a high-lifted container, either to make a tall heap, or direct into a railway wagon; all effected by a combination of a lazy-tongs leverage, with its levers pivoted, for the sake of the tip, at about the rearward third of their length. These lever arms are freely articulated to both container and chassis. Beneath the forward and longer pair of levers are fixed two cam-frames. On these frames bear two rollers mounted on the ends of a T-armed horizontal piston. The pressure of this, against the cam frames, raises the lever arms to effect the lazy-tongs hoist. The same mechanism is employed in another application, for direct backward tipping, without the lazy-tongs lift.

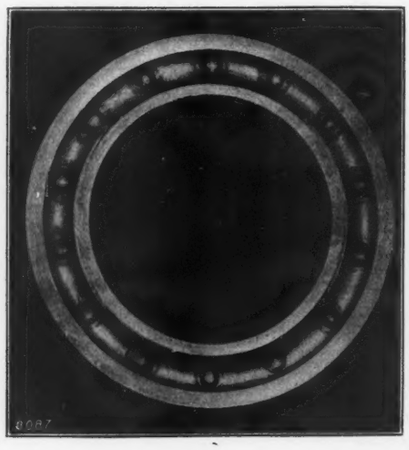
BALL-BEARING LUBRICATION.

By Alexander Duckham, F.C.S., M.I.P.T., and Stanley E. Bowrey, B.Sc., F.C.S.

All machinery involves the employment of metal surfaces moving against one another, and an essential of smooth running is the interposition of some suitable medium between these surfaces to prevent actual contact and to minimise friction.

Oils and greases are of course the media most generally employed. The main difficulty is to prevent the film of lubricant from being expelled by the pressure between the bearing surfaces, and, where forced feed is not used, reliance must be placed upon the remarkable surface tension properties of oil—vaguely called "oiliness"—to keep the film intact.

The ball bearing as an eliminator of friction—the outcome of developments in metallurgy and machine-shop methods—has only in recent years become practical. At first sight such bearings appear to offer an ideal solution to the problem, dispensing entirely with sliding movement and substituting a rolling action which would seem to require no more lubrication than the rim of a trolley wheel. Experience, however, has shown that unlubricated ball bearings, though involving little, if any, loss of power, are noisy and subject to rapid deterioration. The reasons for this are, among others, that in the first place the balls must of necessity be given a little "play," perhaps less than a thousandth of an inch, but still enough to give rise to impact and rebound at high speeds—hence the ringing noise given out by a ball bearing running without the cushioning effect of a lubricant. In the second place there is no such thing as pure rolling motion, for—apart from friction against one another and against



the cage inserted to keep them properly spaced—the balls, like any other rolling part of a machine, are subject to frictional stresses due to temporary deformation under load. Extraordinarily hard as are well-made steel balls, they are nevertheless flattened slightly at the point of contact with the race and the race likewise. Just as an india-rubber ball rolled under the pressure of the foot exhibits frictional resistance roughly in proportion to the load imposed upon it, so does the steel ball under pressure in its races. While the flattening of the steel ball is much less, the pressure per unit area is enormously greater, and the resulting friction is therefore a factor to be reckoned with. The crushing load for an ½-in. ball is about 20 tons, and the "flat" produced, which at this pressure is permanent, is about one-eighth of the diameter. Moreover, the permissible clearances are so fine that the smallest undue wear is detrimental.

In the selection of a lubricant for ball bearings, note should be taken of an important difference between the plain bearing and the ball bearing. With a plain bearing the principal difficulty is to prevent the lubricant from being squeezed out by the load pressure, and to obviate this, either forced feed is employed or more viscous lubricants are used to meet greater loads. With ball bearings this difficulty does not exist. The point at which the load pressure is exerted is constantly changing with the movement of the ball, and the oil film is as constantly renewed. Hence highly viscous oils are unnecessary for ball bearings, however heavy the load, and if an oiltight casing can be provided so that the lubricant cannot escape, a light mineral oil will give eminently satisfactory results. Heavy oil or grease will, of course, function, but the absorption of power by viscous substances (which entails generation of heat) should, when practicable be avoided by using a thin oil.

Viewed theoretically as a problem in lubrication the ball bearing is therefore a remarkably simple proposition for, although it does not quite eliminate the need for lubrication, it obviates some of the greatest difficulties, but at the same time it introduces its own particular complications:—

(1) The surfaces of a plain bearing in good order are not in contact with the atmosphere, and corrosion is therefore unusual. Ball bearings, on the other hand, are extremely liable to rust unless protected by a rust-preventing lubricant. It cannot be too strongly emphasised that pitting or corrosion of either the balls or the races, however slight, will rapidly become the cause of much serious wear and disintegration, just as a single pot-hole in a well-made road gives rise, by continued impact, to a series of holes which grow progressively worse.

(2) The plain bearing retains its oil by capillary attraction, but a ball bearing, unless suitably housed, is liable to throw out the oil by centrifugal force. Hence either an oiltight housing must be provided (which is in certain cases mechanically impossible) or a semi-solid lubricant must be used. Even with the latter some kind of housing is generally necessary.

The semi-solid lubricants fall into three distinct classes, and in each class mineral oil is the principal constituent. In one class of grease the oil is rendered semi-solid by the addition of a substance known as amorphous paraffin wax. Greases of this type are sold under various special names, among which "vaseline" and "petroleum jelly" are most widely known. In another class a compound of fat with sodium, calcium or other base is used to solidify the oil. In yet another class a grease of one or other of these types is mixed with graphite or some other so-called solid lubricant to improve its value for use under heavy loads. This class of grease should not be used in ball bearings because the solid ingredient cannot flow from beneath the oncoming ball with sufficient rapidity, and therefore the ball skids, and this causes a "lapping" action absolutely ruinous to the bearing.

Greases belonging to the first or "vaseline" class, are widely used and possess the advantage that, consisting as they do entirely of hydrocarbons, they do not readily undergo chemical change, and so afford the almost perfect protection from corrosive action. The drawback is that the amorphous paraffin wax melts at 120 deg. to 125 deg. F., and therefore if the bearing approaches this temperature the grease will become liquid, and as greases are employed to obviate the necessity for oiltight housing, it is obvious that if they become liquid they will drain away and leave the bearing unlubricated. Any grease must be adopted with due regard to the maximum temperature reached by the bearing, and if this is in excess of, say, 100 deg. F., it cannot be considered safe to employ the "vaseline" type of lubricant.

The class of grease with a calcium base is the most widely used. It is possible to make a grease of this type with a melting point of 250 deg. F., but those in general use melt at 180 deg. to 220 deg. F. Very many varieties are on the market, and some are entirely unsuitable for ball-bearing work. The calcium or other compound employed for thickening is often prepared in a way which renders it corrosive and so, instead of protecting the bearing, the grease attacks the hardened surfaces with disastrous results. Other greases of this class, although not actively corrosive, contain so much moisture that galvanic action is set up between the different metals of the bearing. The attached photograph illustrates the very characteristic etching effect which arises in this manner. The point of contact of each ball with the race is surrounded by a ring of corrosion marks, due to the establishment of electrical contact between the metal and some conducting constituent of the grease.

Greases belonging to this class are not, it should be explained, absolutely homogeneous, but consist of a spongelike or honeycomb structure composed of the thickening material, the interstices of which are filled with oil. In the best quality grease this honeycomb structure is so perfectly produced that only the use of a powerful microscope can reveal it. Such grease will remain unchanged through a wide

range of temperatures in spite of the violent agitation and of the centrifugal action of a high-speed bearing. Badly made grease on the other hand is liable to separate, the oil oozing away from the housing and the thickening material, resembling fragments of oil soaked india-rubber, remaining.

Sufficient testing of a ball-bearing grease requires considerable time and care. It is necessary to fill up a set of bearings with the grease and set them aside for twelve months or so in order to observe whether corrosion takes place. Further sets of bearings are filled with the grease and run, in a hot chamber or on a shaft heated by steam or gas, in order to make sure that the grease will not separate or otherwise break down under the combined action of heat and centrifugal force. As a further test bearings must be greased and exposed, if not to the direct action of the weather, at least to a damp atmosphere under changing weather conditions, to reveal whether the grease affords sufficient protection against external corrosive agents.

In conclusion, a word of warning is needed on the subject of greasing bearings. A grease package should never be left open. Grit, dust and moisture are often to be seen on the surface of grease thus exposed, and once enclosed in a bearing they will not fail in their destructive work. Moreover, the unfortunate aspect of such carelessness is that its effects are not immediately apparent as in the case of screeching and overheating of a badly-lubricated plain bearing, but they take the form of an initially silent but slow and sure wear and tear in an expensive component, which should last as long as the machine it forms part of. Not only is care necessary to keep the grease as clean as when it leaves the factory, but a dismantled bearing should only be greased up after scrupulous cleaning out. It is not uncommon to see ball bearings dismantled and thrown on the floor or bench of the repair shop amid grit and filings, and whilst one would expect that the iniquity of such carelessness would be too obvious to call for warning, it is a fact that much unnecessary expense and trouble is caused thereby.

HYDRO-ELECTRIC POWER IN ONTARIO.

According to the latest available figures the total horse-power installed in hydro-electric stations in Canada is about 2,763,000. The extent to which this power is now used is indicated by the fact that the figure for horse-power developed per 1,000 inhabitants ranges the Dominion as second only in the world to Norway. In certain provinces, however, the figure exceeds that for Norway to a considerable amount, though in a new country where development is rapid both of population and industry such figures are possibly subject to greater variation than would be the case in Europe. Excluding Yukon, the province with the highest horse-power per 1,000 of population, is British Columbia with the high figure of 584. Quebec stands next, and Ontario third, with 414 h.p. The latter province, however, has the largest total output of any, viz., 1,212,650 h.p., Quebec coming second with 1,015,385, according to the last official reports. Rather more than half the power developed in Ontario is public supply under the control and operation of the Hydro-Electric Power Commission. This Commission which was able to furnish a total of only 750 b.h.p. in 1910, now controls 628,000 h.p., and supplies something like 335,000 consumers. Taking peak loads for the various systems, and including power purchased, according to the report of the Commission for the year ending October 31, 1922, the total power available at any one time was 729,348 h.p., the actual output during the twelve months having been 2,293,447,600 kw.-hours.

The year covered by this report was a notable one in the history of the Commission, owing to the fact that units in the new Queenstown generating station were brought for the first time into service. It will be remembered from the description of some of the turbines installed at this station, which we gave in Engineering, vol. cxiv, page 31, that some of these machines are of 55,000 h.p. Others are of 52,000 h.p. capacity. The first five of these are now in service; others are being installed rapidly, and it is expected the ultimate capacity of this station will amount to no less than 600,000 h.p. The need which has existed for this development was well shown during the year, for the several units were no sooner available than they were put on load, and the demand on the station rapidly increased through the year. The first unit was put in service on January 26, 1922. Almost immediately ice trouble occurred at two other plants, and the Queenston machine was loaded to full capacity, thus obviating restriction of supply to customers. The second unit went into service in March, the third in October and the fourth in December. Since that date the fifth has been in operation. With the exception of the months of April and May, the year 1922 showed a continual increase in the demand on the Queenston station, which was generating at the close of the year about 220,000 h.p.

This development is really rather striking in view of the fact that from an industrial point of view the year was not a satisfactory one by any means. The trade of the country with Europe and the United States was not good, and the purchasing power of the population was restricted. On the other hand there was a shortage of coal, owing to the disturbed condition of that trade in the United States, but various factors show that this temporary inconvenience did not increase the demand for electricity materially. In the months when no heating was required a remarkable increase in demand was shown. Of the several systems operated, the Niagara system showed for such months an increase in demand of 18 per cent. on that in the previous year. In the Central Ontario system the growth was 24 per cent.; for the Ottawa system 23 per cent., the combined Northern Systems 16 per cent., the Muskoka system 24 per cent., the Rideau system 45 per cent., and the Nipissing system 10 per cent. One system showed a slight decrease, and another only a small increase, in both these cases the result being brought about by the action of large consumers, with, in consequence, a material effect upon what in these cases is a moderate total output. On the whole the increase was very satisfactory, and is considered to have been due to an improvement in business conditions generally. Should conditions become more normal, and expansion continue, it is estimated that by the end of 1926 the whole of the presently possible sources of supply available to the Commission will be completely utilised.

The Commission operates 14 different systems and has in use some 3,500 miles of transmission line. The highest voltage transmitted is the 110,000 volts of the Niagara system, which represented at the date of the last annual report some 515 miles, with about 7 additional miles then under construction. For four-fifths of this mileage double circuit lines were carried, while the remaining one-fifth of single-circuit lines was being arranged for a probable change to double circuit in the future. The longest span on the double circuit high tension lines is 880 ft. and conductor 605,000 cm. steel reinforced aluminium. The highest steel towers are 205 ft., on the Queenston-Burlington trunk line, at the crossing of the Welland Canal, where a clearance of 150 ft. above water level is provided. During the year under review transmission suffered considerably from two ice storms, one on February 22 and the other on March 31. The former was the worst experienced in the history of the Commission, and did a considerable amount of damage; practically all the lines between Niagara and Stratford suffered extensively. Before this damage had been made good the second storm occurred, and was even more severe than the first, and still greater damage was caused.

Next to the new Queenston generating station ranks the Ontario Power Company plant, with however an output of less than 200,000 h.p. During the year under review this plant met with a serious accident owing to the bursting of a generator rotor. The capacity disabled through this accident amounted to 25,000 kw., with additional 40,000 kw. out of service temporarily through flooding. The occurrence followed upon a heavy short circuit subsequent to which the turbine raced, attaining a speed which the generator rotor could not stand. Failure resulted through a defect in the casting. The bursting of the rotor was immediately followed by the collapse of several roof trusses, and the fall of the reinforced concrete roof as a result of which the turbine casing was damaged. A second generator near by was wrecked by pieces from the first, some of which were hurled great distances. The water was fortunately soon got under control, and although the accident occurred at 2·44 a.m., by 7.30 the same morning the station was able to carry its normal day load. During the year one of the pipe lines of this plant was shut down for inspection. The line in question is 18 ft. in diameter and of ½-in. steel plate encased in 12-in. of concrete. It was laid in 1905, and had been in continuous operation for the seventeen years since that date. A careful inspection revealed no deterioration whatever, the mill scale being still on the plates on the interior, while test holes cut through the concrete showed the outside to be equally good.

The so-called Combined Northern Systems of the Commission have an output of about 13,277 h.p., and the year 1921–22 illustrated in a marked degree the advantages of the policy of linking up which has recently been followed by the Commission. Two sections of this group consist of the Eugenia and the Severn systems. In connection with the latter navigation interests have to be taken into account and a regular minimum flow maintained. In the Eugenia systems no such interests are involved. The year was abnormal as regards rainfall, and the demands for power were only met by conserving the water impounded on the Eugenia system and generating, while this was held in reserve, as much as possible at the other plants. Thus the Severn and Wasdells plants generated power by means of water which would otherwise have gone to waste over spillways, and the Eugenia supplies were utilised subsequently.

To enter into all the incidents of the year on a system with such wide ramifications as the "Hydro" would occupy more space than can be devoted to the subject. Stations seem to have been troubled by a number of shaft failures, but in no case did serious interruption to supply follow. On the Nipissing system an occurrence which in a country such as Canada must be decidedly uncommon, has to be recorded. The Braie Lake Dam was blown up by dynamite by some one unknown. This loss of storage was seriously felt.

As regards actual construction during the year the most impressive work was the rapid advancement of the Queenston plant, to which we have already alluded. This applies to the construction of the buildings, screen house, intake works and canal. The first 110,000-volt outdoor transformer station with an initial capacity of 15,000 kv.a. was brought into service on the Niagara system at Hamilton. Outside the Queenston plant the most important new generating station brought into use was one at Ranney Falls, forming part of the Central Ontario and Trent system. Here two 4,500 kv.a. units were placed in service, generating three-phase 60-cycle current at 6,600 volts. This current is stepped up to 44,000 volts for transmission.

THE MOTOR EXHIBITION AT OLYMPIA.

(*Concluded from page* 589.*)

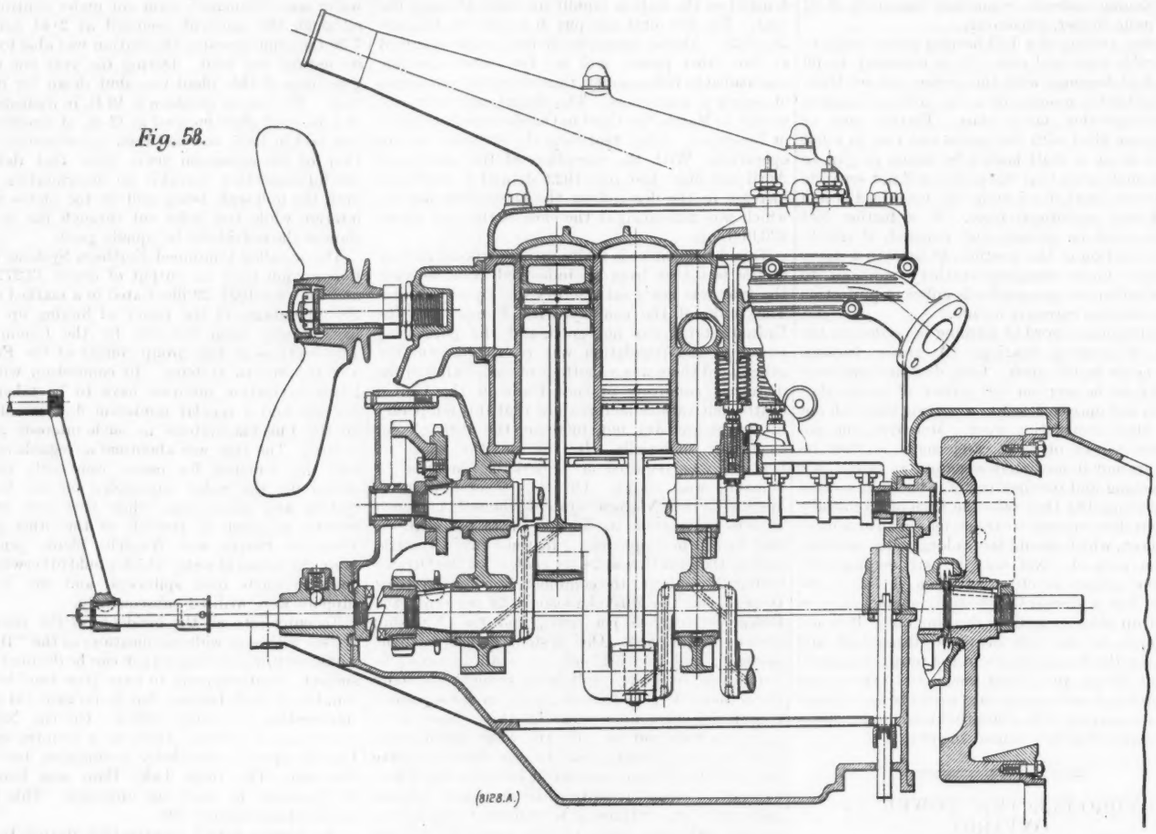
The firm of Wolseley Motors, Limited, deservedly got a very good reputation for the qualities of design and construction of their motor cars in early days, and have consistently retained their position among the leading manufacturers throughout the growth and development of the application of motor traction. Whenever new materials became available, as metallurgical problems were solved, advantage was made of their use in these cars, and by the continuous improvements in the various components of the complete equipment the firm were able to meet the increasingly exacting demands of the motor-using public. That this was so was evident from the results of the various trials, and the position to-day is clearly indicated by the remarkable records established at Brooklands with a standard 15-h.p. Wolseley car, modified only to suit the track

* Owing to a printer's error two of the figures on page 589 bore the same number. The brake of the A.C. cars should be Fig. 47 instead of Fig. 44, and the same alteration should be made in column 2, line 6, while in column 3, line 4 should read "Figs. 44 and 45, while Fig. 46".

10-20-HORSE-POWER ENGINE AT THE MOTOR EXHIBITION AT OLYMPIA.

CONSTRUCTED BY GALLOWAY MOTORS, LIMITED, DUMFRIES.

Fig. 58.



conditions. This model, which may be taken as representative of the design and construction adopted by the firm was run on the track at Brooklands for a period of 12 hours. In that time a distance of 1,015 miles was covered, which gives an average speed of 84·6 miles per hour. The records were thus broken for cars of its class for all standard distances between 100 miles and 1,000 miles, and for the periods of from 1 hour to 12 hours. Not content with even this great achievement, the car was kept under seal overnight and run for a further 12 hours on the following day. The total mileage was brought up to 1,922·9, giving the average speed for 24 hours as 80·1 miles per hour, thus making new records in its class, and, indeed, breaking the record for the British double 12-hours' run, irrespective of class.

The details of construction of the parts of this 15-h.p. model are shown in Figs. 48 to 57, on Plate XXXVI. The chassis frame, Fig. 48, is constructed of pressed steel and is of tapered channel section, with cross-bracings. It is supported from the front and rear axles by heavy cantilever springs. A steel drop-forging of substantial design is used for the front axle, Fig. 49, and it carries the pins on which the hub swivel bearings are mounted. The front wheel, it will be noticed, runs on roller races of the Timken pattern. The engine, Figs. 50 and 51, affords an interesting example of the type fitted with an overhead camshaft. For the driving of this there is a double transmission. First the motion of the crankshaft is taken to a countershaft immediately above it by an inverted tooth chain which dips into the oil bath, and then the drive is continued through a vertical shaft with bevel gearing to the camshaft. The valves are seated on the inclined face of the cylinder head and are actuated by rockers centred below the camshaft. On the ends of the rocker arms there are set screws through which the motion is given to the valve spindles, and these afford a ready means of adjusting the clearances. The camshaft is efficiently lubricated from the general system through a pipe from the pump, and the overflow is carried by a channel in the engine casting back into the sump. For the lubrication purposes the base of the engine crank-case forms a reservoir from which the oil is drawn through a detachable strainer to the pump. Oil is delivered to the three crankshaft bearings and the troughs which span the crank-case under the cranks. A pressure gauge on the instrument board gives the driver knowledge of the oil pressure in the general system. The aluminium alloy pistons are lubricated by splash from dippers on the connecting rods. The water circulation is maintained through the use of a centrifugal pump of simple design shown on the right of Fig. 51. The petrol is fed to the carburettor through an Autovac. The clutch, Fig. 52, is of the multiple steel disc type entirely enclosed and running in oil. From this the drive is taken through a universally-jointed shaft to the gear-box which is of the sliding spur-wheel type, with gate change, and gives four speeds forward and a reverse. The arrangement is made so that no accidental engagement with the reverse is possible. Figs. 53 to 55 show the details of the gear system, and it should be mentioned that the direct drive is obtained with the top speed. From the gear-box a propeller shaft with universal joints is continued to give the drive to the spiral bevel wheel on the back axle. This part of the mechanism is clearly illustrated in Fig. 56, where also the location of the differential pinions is shown. With the bevel wheel the planetary system of wheels revolves and the motion so obtained for the axle shafts is transmitted through to the wheels. The hubs run on tapered roller bearings and, connected to the hub on the inside is the brake drum. Within each drum there are two pairs of shoes. One pair is actuated quite independently of the other, and they are set into operation by the movement of a hand lever in the one case, and by motion communicated through a lever system from a pedal in the other. The fabric linings of the shoes may, of course, be renewed whenever necessary, and means of adjustment are provided on the pull rods and also for the pedal.

The 21-h.p. Lanchester attracted a great deal of attention at the Exhibition. It has monobloc construction for the six-cylinder engine and the common water jacket is internally webbed to obtain stiffness. A crankshaft with eight journals is provided, and the aluminium crank case is suitably provided with webs for their support. Between the last pair of bearings there is a skew gear wheel, mounted on the crankshaft, which drives a vertical shaft, at the top end of which there is another set of skew wheels to drive the camshaft. The overhead valves are inclined towards one another, and are operated by rocker arms of which the centres are supported on the opposite side of the cylinder head from the valve. A balancing cam is fitted to the camshaft to prevent irregularities in the torque due to the action of the cams that are working. This has six faces which are pressed in turn against a spring-loaded plunger. A centrifugal water pump for cooling water is also driven from the skew gear on the crankshaft but through a countershaft. In this pump end pressures are balanced by having double suction ports, and thus leakage through the pump spindle bearing is prevented. All four wheels of this cam are provided with brakes. One feature in the system is distinctive. It is that only one pair of brake shoes is fitted to each of the rear brake drums, and these can be put into action by hand alone or with those on the front wheels, through movement got from the brake pedal. The front wheel brakes are actuated by universal cams beneath and in exact axial alignment with the steering pivots. This arrangement ensures their effective operation at all angles of the front wheels, whether due to pivoting or turning. The Lanchester Motor Company, Limited also showed their larger model of 40 h.p., which embodies many of the early

GEAR-BOX AND BACK AXLE; GALLOWAY MOTOR CAR.

CONSTRUCTED BY GALLOWAY MOTORS, LIMITED, DUMFRIES.

Fig. 59.

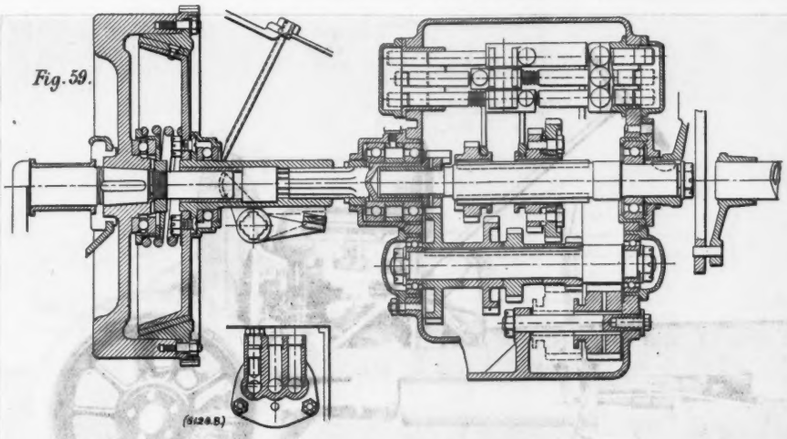
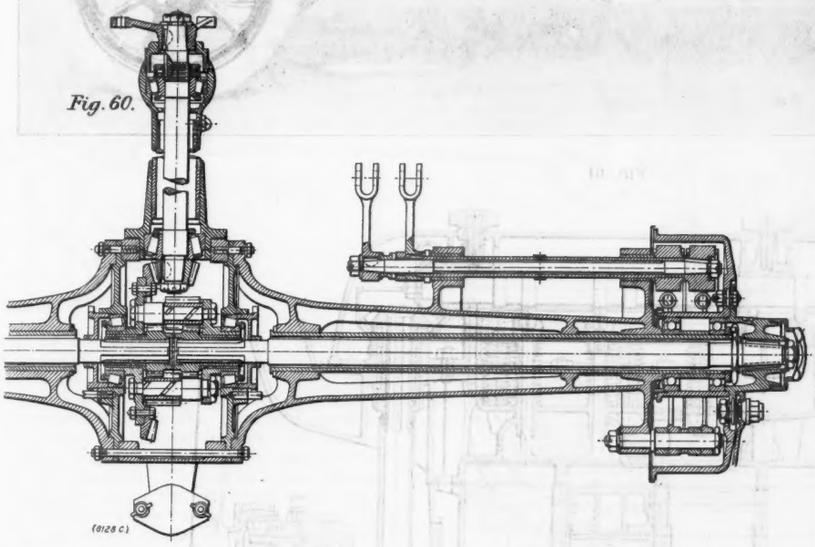


Fig. 60.



original ideas on motor car construction of Dr. F. W. Lanchester which have now become standard practice with many manufacturers.

No appreciable changes are to be seen in that good example of mass production work, the Morris-Cowley. This must, of course, be anticipated as the design must be standardised if the aims at producing a low-priced motor vehicle, which has characteristics which will appeal to the British people, are to be attained. The merits of the design have been recognised both in regard to the production activity in the works and in the service of the owner on the road. That one British firm has produced a reliable and efficient motor as an alternative to the low-priced vehicles obtainable from other lands is now proven and is a piece of work on which they must be congratulated. Certainly the Morris-Cowley shows many merits in the design of engine and transmission system, and has, in spite of its low price, a most attractive appearance. The improvement of service conditions which have been effected will tend to increase the popularity of these soundly designed and well constructed cars.

The new features introduced into the design of the 40-50 Rolls-Royce are a four-wheel braking system and automatic control of the battery ignition system. The brakes on the front wheels are hydraulically operated. An additional carburettor is fitted for use in starting so that a very rich mixture may be obtained when starting. At the main carburettor there is an exhaust jacket which ensures, with the earlier introduced thermostatic water circulation control, that the engine may quickly attain a steady temperature and even running condition.

The 10-20 h.p. Galloway may be cited as an example of a British motor car with an R.A.C. rating of only 10·9 h.p. but embodying many details in its design which are usually only looked for in the more powerful classes of motor cars. The wheel base, for instance, is long, as it was the desire of the designer to obtain as complete immunity from skidding tendencies as is possible. Another characteristic is the use of a four-speed gearbox with a right-hand change system. In many details of the construction there are also unusual features which will be referred to as the components are reviewed in order. This car is built by Galloway Motors, Limited, at Heathhall, Dumfries. The engine is illustrated in section in Fig. 58, page 614, while the clutch and gearbox are shown in Fig. 59, and the rear axle construction in Fig. 60 on the present page. The Galloway engine is of the monobloc type with four cylinders of 66·5 mm. bore and 110 mm. stroke. The valves are all in line and are given movement from the cams which are cut out of the solid with the camshaft. Each tappet has a roller at its end and has provision for length adjustment to ensure that the correct clearance between the end of the valve stem and the top surface of the tappet can be obtained. The adjustment is easily and quickly effected as the valve operating system can be got at instantly by the removal of the detachable side cover. The crankshaft runs in three bearings fitted with white metal bushes. Lubricating oil is fed from a gear pump in the sump through a pipe system, and its passage to the big ends is ensured by channels cut through the crankshaft. The clutch, Fig. 59, is of the inverted cone type faced with Ferodo and entirely enclosed and arranged so that adjustment for wear is completely automatic. The gearbox, as has already been indicated, gives four speeds and reverses. The arrangement of the three selector bars through which the sliding motion is transmitted to the gears are seen at the top of the plan of the system, Fig. 59, and as this is to the right side of the gears in the case, the motion can be given to it through a shaft from an operating lever placed beside the brake one. The back axle is arranged so that the driving shaft is free from all but torsional stresses and all shafts within the differential are mounted on roller bearings, while the hubs are run on ball bearings. The differential wheels are of the simple spur type. Both hand and foot brakes operate on the same drums on the rear wheels. In this example the brake blocks sit side by side. One is put into action by the motion given to a solid shaft while the other is operated through the sleeve which surrounds that shaft. The arrangement is clearly indicated in Fig. 60, and connecting arms which receive motion from the link systems from pedal and hand lever are also shown.

The well-known 8-h.p. Rover car is a compromise of light car and cycle car practice, and one which has found a considerable market. The dominant factor in the layout and the design of components in this machine was low cost, and though that was the case reliability was not sacrificed. This was due to the consideration that must have been given to every item in the design. The engine is an air-cooled one of two cylinders with L-shaped heads. The inlet and exhaust pipe systems are mounted above the horizontal engine. A single plate clutch and a three-speed gearbox are mounted as parts of a complete unit with the engine. Transmission is effected through a Hardy fabric universal joint to a short steel bar riveted into a tubular propeller shaft. In the final drive, which is by worm and worm wheel, the worm shaft is mounted in ball journal bearing and the wheel is gripped between the two parts of the differential cage which are mounted with similar journals. Simple spur wheels are employed in the differential. Those on the axle shafts are held in place by split rings sitting in grooves cut near the ends of the shafts. The inner face of each wheel is recessed to surround the projecting part of each spring ring. The design throughout is of interest, especially when the comparison with an older model is possible. This car, the product of the Rover Company, Limited, of Meteor Works, Coventry, was the first air-cooled light car which had a reasonable degree of freedom from noise in running. Altogether the model, as now constructed, is a sound attempt at cheap production, and one which will meet the demands of a very large circle.

Two stroke engines are used on the Loyd-Lord motor car. These have two or four cylinders, but in the latter case two carburettors are used and two induction systems are provided. The inlet mixture is drawn into one annular-shaped chamber surrounding the crankshaft and occupying the space between the pairs of disc cranks. Apertures in the wall of the gas space give communication to the cylinders but only when the ports cut in the disc cranks register with the two openings. It is claimed that a supercharging effect is obtained at the inlet of the gases. Among the many distinctive features of this engine is the possibility of removing the pistons from above, after the detachable head is removed. This is obtained by having the gudgeon pin mounted in a cylindrical casting which has a shoulder and a shaft extension with a thread cut on it. The piston has an internal boss which rests on the shoulder and has a hole drilled through it for the accommodation of the shaft. It can be removed from position by slacking the nut and then pulling the piston away from the shaft.

An unorthodox system of varying the relationship between the speeds of the engine and the tail shaft is incorporated in the four-cylinder cars made by G. W. K., Limited, of Cordwalles Works, Maidenhead. This consists of a friction drive between the flywheel and a disc mounted at right angles to it, and having upon its circumference a fabric tyre. An infinite variation of the speed ratio is possible with this method, as the disc is moved so that its edge travels outwards from the centre of the flywheel.

The 10-h.p. Wolseley car has an individuality all

10-HORSE-POWER WOLSELEY CAR AT THE MOTOR EXHIBITION AT OLYMPIA.

CONSTRUCTED BY WOLSELEY MOTORS, LIMITED, BIRMINGHAM.

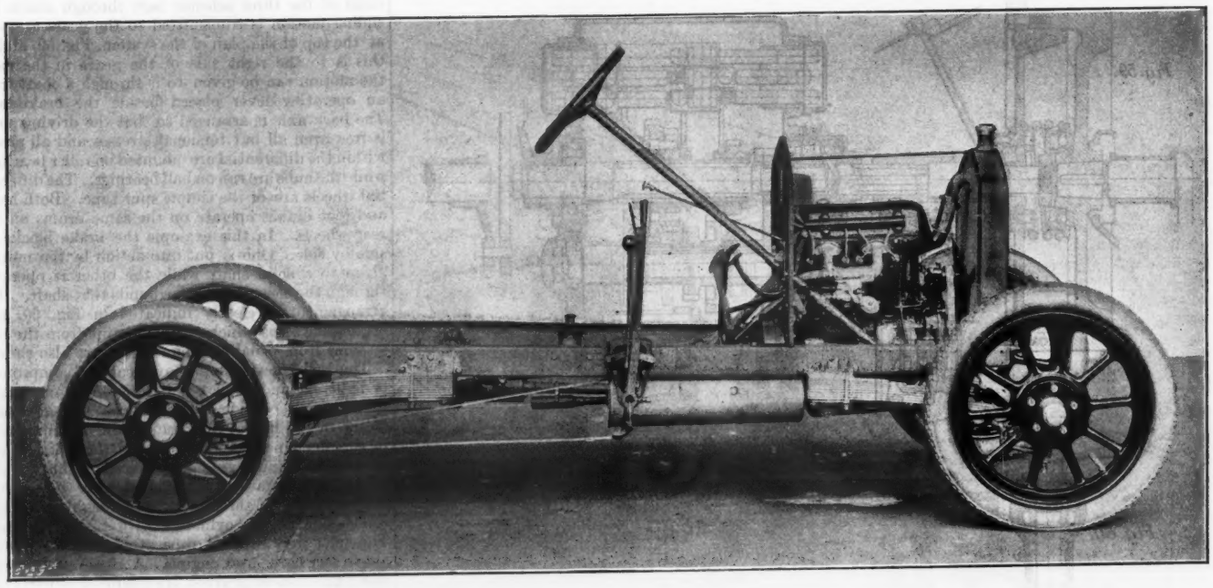
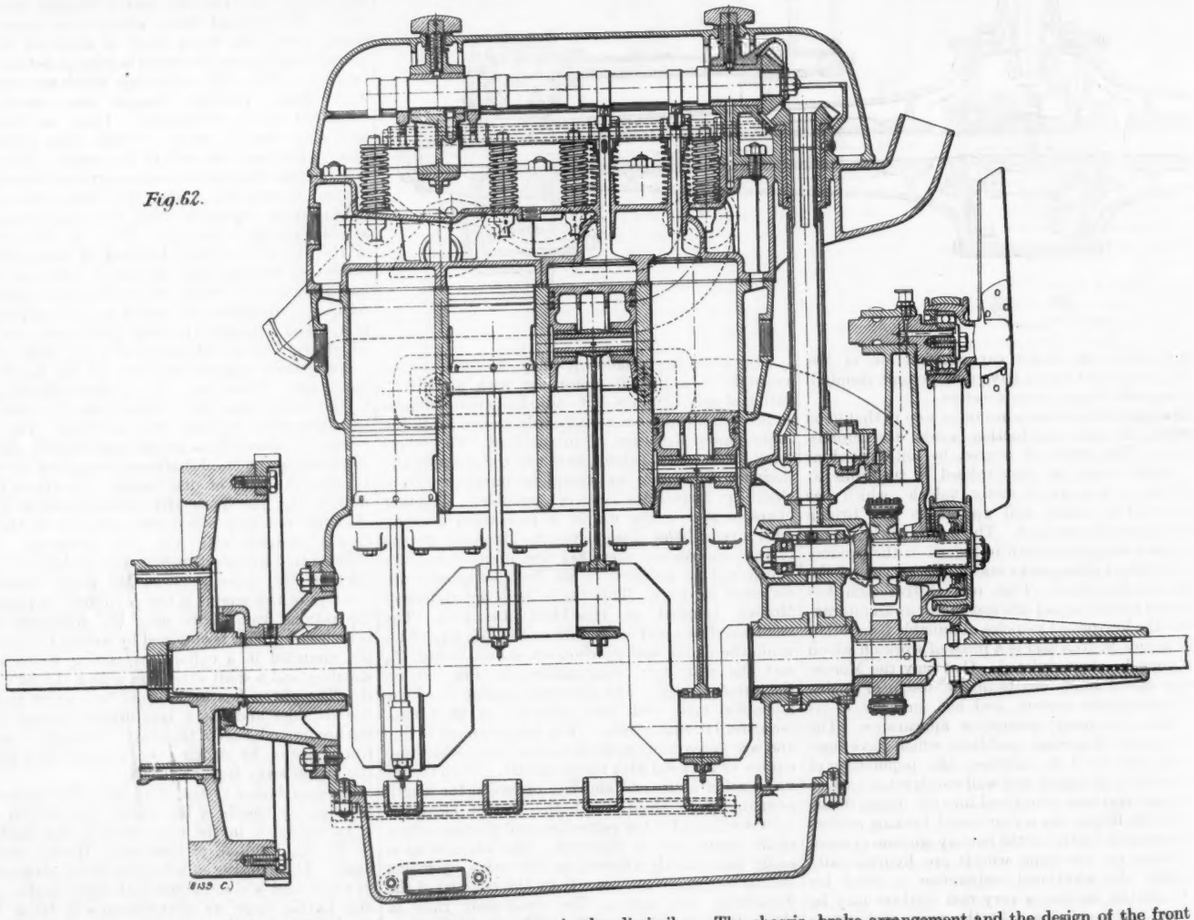


FIG. 61.

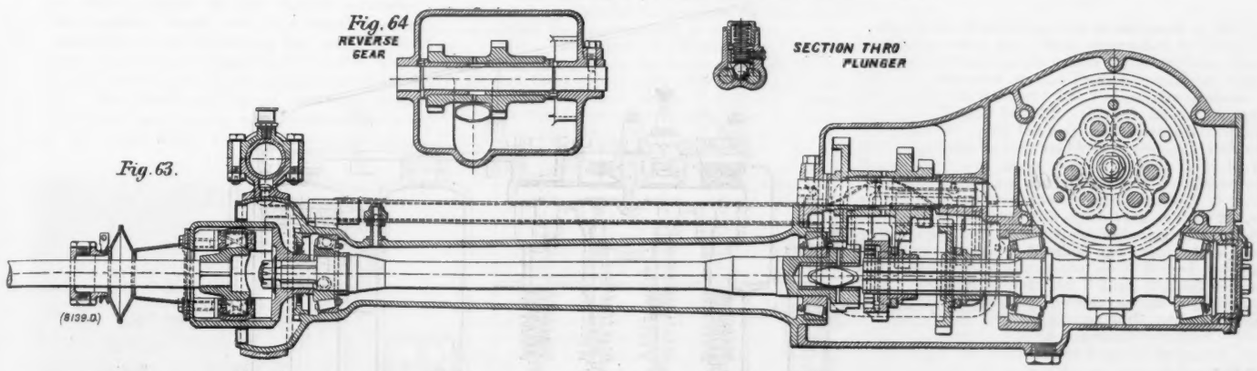
Fig.62.

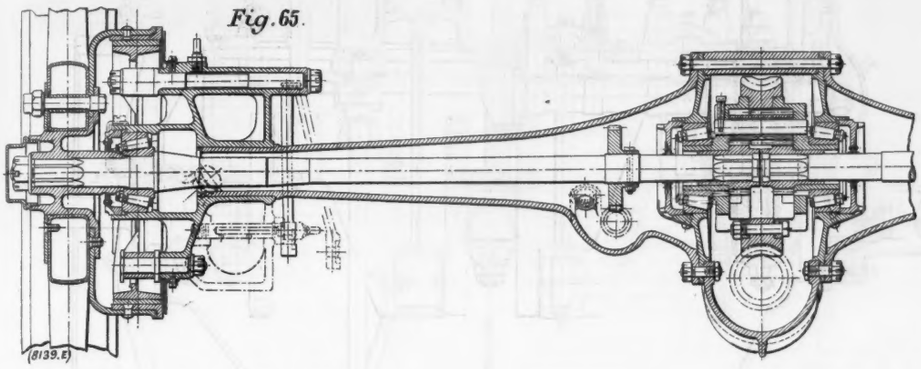


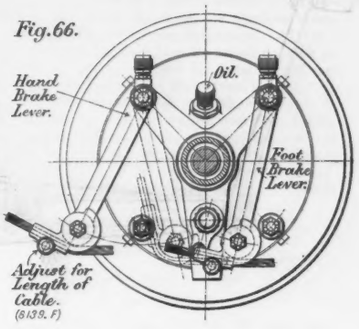
its own and is not merely a smaller reproduction of the 15-h.p. model which was described earlier in this article. Many features of the engine are quite different from that of the larger machine, and the transmission system is also dissimilar. The chassis and the details of construction of the engine are respectively shown in Figs. 61 and 62 above, while the transmission system, gearbox, back axle brake arrangement and the design of the front hub are illustrated in Figs. 63 to 67 on page 617. The chassis frame is built up of two straight pressed steel members of tapered channel section, cross

DETAILS OF 10 HORSE-POWER WOLSELEY CAR; MOTOR EXHIBITION AT OLYMPIA.

CONSTRUCTED BY WOLSELEY MOTORS, LIMITED, BIRMINGHAM.

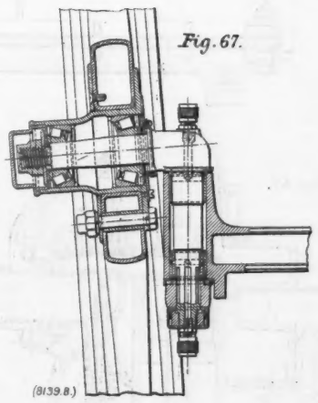






braced to ensure complete rigidity. The engine, Fig. 62, is a four-cylinder monobloc unit in which the cylinders have a bore of 2 7/16 in. and stroke of 3¾ in. The crank has two bearings and the two inner and two outer cranks are in line. Overhead valves are used, and they are operated from an overhead camshaft receiving its motion from a vertical shaft driven by bevel gears. The motion is taken through a countershaft above the crankshaft driven by a chain which dips into an oil bath at the foot. The rockers are centred on the other side of the cylinder head from that on which the valves are located. The pistons are made of cast-iron and lubricated by splash from dippers. The lubrication system is automatic. Oil is drawn through a detachable strainer to the pump which is driven from the vertical shaft. It is delivered to the crankshaft bearings and the troughs for the dippers which run across the oil base. A pipe also feeds to the camshaft and rocker bearings from which the surplus is run back into the sump.

The clutch is of the multiple steel disc type, is fully enclosed and runs in oil. From here the drive is taken through a flexible disc to the first motion shaft of the gear-box through a propeller shaft with universal joints at each end. Fig. 63 shows the general arrangement. The torque tube is rigidly bolted to the axle casing at the rear end and is carried on a swinging ball socket at the front end. In this model the gear-box is a part of the back axle casing. The various combinations of gear wheels give three speeds ahead and a reverse. A joint system of lubrication for gears and live axle is a feature of this layout. The rear axle is fitted with worm gearing, and end play in the worm shaft can be taken up by the adjustment of the Timken roller bearings, which are also used to take the thrust on the system. The arrangement of the differential is clearly shown on the right of Fig. 65. The axle shaft bearings near the road wheels are enclosed in the ends of the axle tubes. Brakes of the internal double-acting shoe type are incorporated in the design. The diagonally-opposite blocks or shoes are operated together, the one pair from a hand lever and the other from a pedal, and Fig. 66 shows the hand block lever on the left, and the foot brake



lever on the right. These are pulled over into the operating position by steel cables which are clamped to them at their ends. A front axle which is a steel drop-forging carries the swivel axles for the hubs in plain bearings. The details of this construction are shown in Fig. 67.

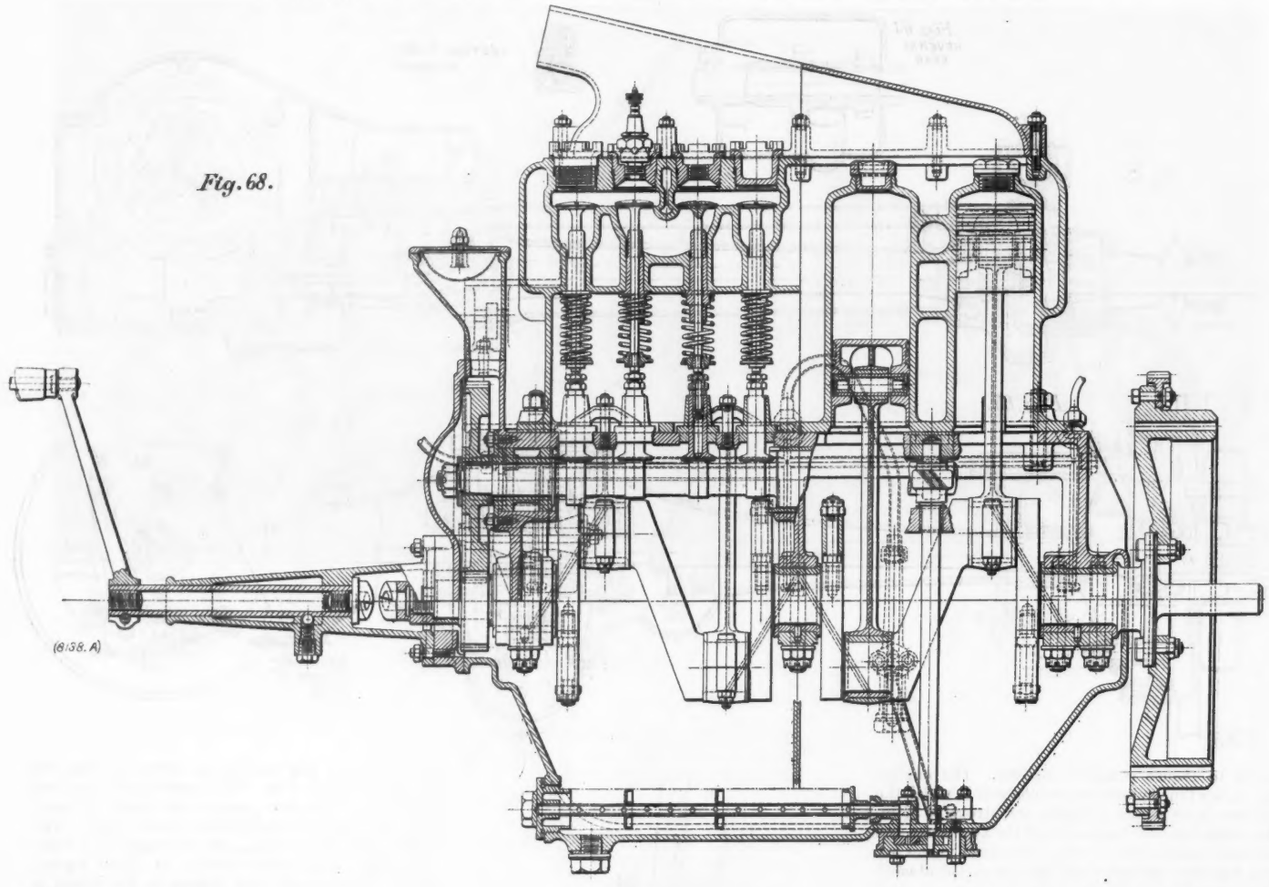
The endeavour to produce a motor car which is moderate in price but is faster than many machines of which the engines have the same engine dimensions is shown in the design of the Alvis. The company which manufactures this motor car, the Alvis Car and Engineering Company, Limited, of Holyhead-road, Coventry, have attained a great measure of success in the tests of their productions. In the International 200 Miles Light Car Race at Brooklands on October 13, an average speed was maintained of 93·3 miles per hour, the premier award was won and new records set up for the distance. The machine in use in this race had overhead valves operated by push rods and was a production machine. Although more successful with this sports model in contests a large measure of success has also been attained with the standard car of which the engine has side by side valves. The engine of this machine is shown in Figs. 68 and 69, on page 618. This power unit has four cylinders of monobloc construction made of cast-iron, and of 68 mm. bore and 110 mm. stroke. The R.A.C. rating is 11·5 h.p., but the engine is a high-speed one, and when running at 3,800 r.p.m., 40 h.p. is delivered. One feature in the design is the large water space surrounding each valve spindle. Valve caps are screwed into the casting and those above the inlet valves accommodate the sparking plugs, while steel plugs close the holes in the tops of the cylinders. Stainless steel is used for the exhaust valves while nickel steel is the material from which the inlet valves are made. The form of the valve guides and the nature of the tappets may be seen in both illustrations, Figs. 68 and 69. Machined all over from a stamping of high tensile steel, the crankshaft is solid, but has balance weights fitted to each throw. The pistons are made of an aluminium alloy. A vertical pump driven by skew gear from the camshaft and situated on the centre line between the last two cylinders, Fig. 68, delivers oil to a system of pipes through which it passes to the various bearings and through holes in the crankshaft to the big ends. It should be noted that the pump is external to the sump, but in communication with it. The oil actually passes from the sump through a tubular filter which has a perforated tube within and which is in communication with the pump.

The exhibition afforded an indication that the manufacture of accessories of all types for motor vehicles is well established, and in many examples exceptional features were manifested. Of these the method of regulating the charging of the battery on a motor car introduced by the British Lighting and Ignition Co., Limited, is of exceptional interest. This is a new means of controlling the output of electricity of a motor car dynamo, so that the charging rate of the cells is changed to suit the needs of the battery. The three-brush type of generator commonly installed on motor cars has the characteristic that its output is diminished as the pressure across the cells is lowered. This, of course, is the opposite of what is really necessary, for the cells need their greatest charging current when they are

12-40 HORSE-POWER ALVIS ENGINE; MOTOR CAR EXHIBITION AT OLYMPIA.

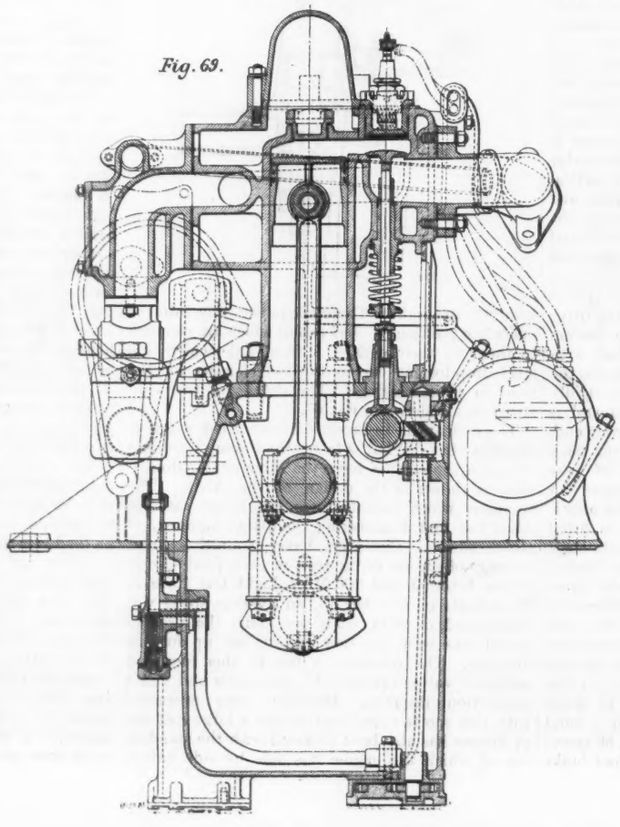
CONSTRUCTED BY ALVIS CAR AND ENGINEERING COMPANY, LIMITED, COVENTRY.

Fig. 68.



depleted. The scheme consists in connecting a number of electrolytic cells as a shunt across the battery. For the passage of current through these a certain pressure is required, and until that value is available all the output of the generator passes through the battery. When the battery is fully charged its pressure is high and so also is that of the generator, but it is sufficient to allow the passage of current through the electrolytic cells, and that is the path that the greater part of the current will take. In tests, which we have witnessed, the charge current varied in a way that suited the condition of the battery, that is at a heavy rate when depleted and at a slow rate when there was a large storage. This appears to be the best attempt we have yet seen to charge the batteries at reasonable rates and eliminate the necessity for removing the battery for recharging when it becomes run down. Fig. 70 shows the electrolytic cells inserted at the end of the battery box, while Fig. 71 shows how they are connected on the circuit. The electrolytic cells which regulate the system consist of a number of short steel compartments containing flat perforated plates. These are erected in units as seen in Fig. 72 and are immersed in an alkaline solution. While the level of liquid remains above the plates no corrosion takes

Fig. 69.



place but the cells will continue to operate satisfactorily if there is any immersion at all. The savings in battery maintenance by this sensible method of regulating the charge must be very great and the B.L.I.C. regulator must, therefore, be regarded as perhaps the most outstanding of all the accessory displays of the show.

This great Motor Exhibition, perhaps the most wonderful yet held, has taught us many lessons. Firstly, the position of the motor trade of our Homeland is very good, and the characteristics of British designs are so excellent that they are unsurpassed by those of any country. At the present time there is a great agitation about the necessity for making use of British tyres only. That is a sound view, for there are no superiors, but the merits of the work of British motor car manufacturers require greater recognition than they receive, and actually the time has been reached when the purchase of non-British motor cars, which does an injury to British industry, is decidedly a bad bargain for the purchaser. The development of design is very interesting, although the mechanism of a car is becoming more and more stereotyped. Overhead values are growing in favour and high engine speeds are becoming more popular. That is to be anticipated, as materials of better physical

properties are being continuously introduced, and a better understanding of the effects of the shape of cylinder head in obtaining effective and rapid combustion is obtained. The greatest change in the characteristics of the models exhibited was the number fitted with four-wheel brakes. This development is interesting, but some of the examples shown do not comply with the law, which specifies the requirement of two independent braking systems. The double motion of the front wheel due to pivoting and turning makes difficult the provision of a gear which enables the brakes to be

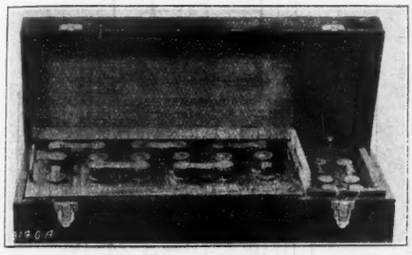


FIG. 70.

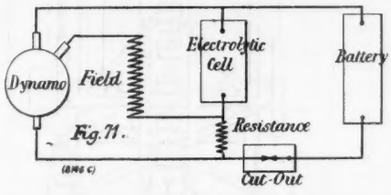


Fig. 71.

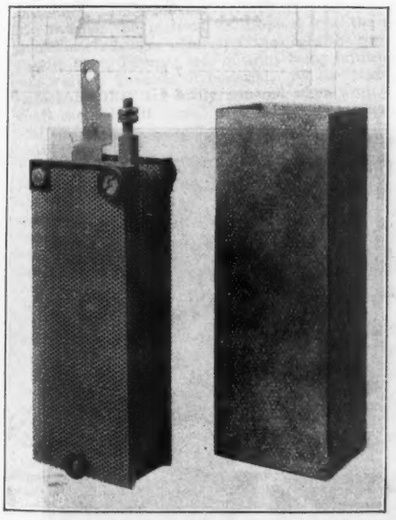


FIG. 72.

operated no matter what position the wheel is in. Very ingenious design has enabled the difficulty to be overcome and ample safety assured under all conditions. It is highly probable that an increasing number of four-brake systems will be applied in the future, since a reasonable state of perfection in design has now been reached. There is increasing evidence of the introduction of production methods in the workshops, and the cheapening of the manufacture has enabled the makers to make substantial cuts in their prices. Progress has now reached such a state that reliable machines with satisfactory running characteristics and offered at low prices were to be seen on almost every stand in this very remarkable motor exhibition.

PERSONAL.—Mr. A. Bonus, coal exporter, coal contractor and shipbroker, 17, Philpot-lane, London, E.C. 3, states that he has taken over the office of Messrs. Howell and Hurst, and has been appointed agent for the Business Statistics Company, Limited, Cardiff.

NOTES ON NEW BOOKS.

One of the most interesting of all the applications of the internal combustion engine is in the propulsion of motor boats and ships. Actually that service was demonstrated by Daimler at, or about, the same time as he applied his improvements in motor engines to road vehicles. Enormous developments took place in the succeeding years in the design and manufacture of cars, but the progress made with motor boats was much smaller and much slower. The little petrol engine has found somewhat extended use on boats, although the peculiar conditions of this service can hardly yet be said to be completely met. In the application to larger vessels, the development of recent years has been very great and the power plants have reached a very high state of perfection and efficiency. There are many non-technical people who are interested in both the small and the large vessels of this type, and Major F. Strickland has now written a book with the title "*Motor Boats*" to meet their requirements. This work was recently published by Sir Isaac Pitman and Sons, Limited, of Parker-street, London, at a price of 3*s.* net. It is a very readable little book in which the salient features of the engines, gears and general arrangements of the boats are brought out in a very interesting way. In it the advantages of the system of propulsion are dealt with, the properties of various fuels are discussed, the relationship of engine speed, power and weight are demonstrated, and examples of designs are illustrated and described. The action of skimming with motor craft designed to attain very high speeds is referred to, and the work is concluded with a forecast of the future possibilities of the system of propulsion.

Because of the necessity of exact definition it is essential that instruments of measurement and their use should be a subject for study by all engineers. Fundamental matters of this nature have not always received the treatment they deserve by the authors of text books. In that phase of the subject connected with electrical measurements, either to obtain a direct determination of some quantity, such as pressure current or power, or for the deduction of non-electrical actions from electrical effects they may be caused to produce, the question has been rarely looked at from the standpoint of commercial and practical activity. Frequently the subject of instruments has been tacked on to the treatment of methods of testing, and not always with satisfactory results. In some works the tendency has been to consider the subject solely from the standpoint of the physical actions involved. There is no doubt that the subject of "*Electrical Measuring Instruments and Supply Meters*" warrants treatment from the point of view of engineering practice, and therefore we welcome a book with that title which Mr. D. J. Bolton, of the Regent-street Polytechnic, has written for Messrs. Chapman and Hall, Limited, and which they have recently published at a price of 12*s.* 6*d.* net. The author has kept well in mind the requirements of his readers and has assumed no knowledge beyond that which a young student would acquire in the second year of his study of electrical engineering. In this book the advantages and limitations of the various types of commercial measuring instruments, in regard to sensitivity, power and consumption are brought out in a very clear fashion. Where different constructions are possible the statement of their relative merits is given in tabular form in association with comparative costs. Old types of instruments have only been introduced where it was thought that the explanation of their action made the understanding of some derivative commercial type a matter of greater ease. In addition to contributions on ammeters, voltmeters, wattmeters and supply meters there are chapters in the volume on oscillographs, frequency and power factor meters, iron testing instruments and pyrometers.

After five years of deliberations the Normenausschuss (Standard Committee) der Deutschen Industrie (N.D.I.) has issued, and has itself, published a report and general guide on limit gauging, drawn up by K. Gramenz, under the title, "*Die Dinpassungen und ihre Anwendung*," an illustrated pamphlet of 172 pages which has warmly been welcomed in Germany, though it is naturally only of relative value in other countries. Of the various fitting systems in use in Germany, those of A. Kirsch, of Ludwig Loewe and Co., and of J. E. Reinecker enjoyed most favour. They all admitted of tolerances both on the hole and on the shaft, but they differed as to reference temperature and datum line. The report does not lay down a general rule for the tolerances, but it decides in favour of 20 deg. C. (68 deg. F.) as reference temperature (instead of 0 deg., 14 deg. or 20 deg. C.), and of the limit line as datum line. As regards the precision of the fit the terms *edel*, *fein*, *schlicht* and *grob* are proposed, which may be rendered superior, fine, satisfactory and rough. One word about the term *Dinpassungen*. The Din stands for Deutsche Industrie; but that expression is otherwise abbreviated D.I., and such compound words as *Dinpassungen* (without hyphen) for din-fittings, *Dinbücher* (din-books) appear reprehensible.

Should the Poulsen arc ever be relegated to the list of devices which have been superseded by later inventions, as many people believe will be the case, those who are interested in the Poulsen system of radiotelegraphy will have in "*The Poulsen Arc Generator*," by C. F. Elwell, M.I.E.E. (Ernest Benn, Limited, London, 1923; price 18*s.* net), as complete a description of the apparatus as they are likely to require. Had the thermionic valve never been invented, it is likely that the Poulsen arc would have held a commanding place in wireless transmission, and even as it is there are about 80 stations, with inputs ranging from 25 kw. to 1,000 kw., using the system, including those of the British Post Office at Northolt and Cairo, which form the first and only link in the much desired Imperial chain. In 1900 the late Mr. William Duddell demonstrated that an ordinary arc was capable of producing continuous electrical oscillations, although only those of low frequency could be practically obtained. Two years later Dr. Valdemar Poulsen improved the apparatus, and by causing the arc to work in an atmosphere of hydrogen produced a device which would give the continuous waves so desirable for wireless transmission. For the theory of the apparatus and for a description of the forms in which it, together with its auxiliaries have been developed for commercial use we would refer our readers to Mr. Elwell's book. In this they will find pretty well all there is to be said on the subject as well as a most complete bibliography containing references to the writings of 127 authors. The book is well illustrated and adequately indexed, and will prove of interest to all who are concerned with the practical development of wireless transmission.

THE ADMIRALTY AND THE LATE REV. C. M. RAMUS.

THE subjoined letter dated October 24, has been received by Miss Ramus, daughter of the late Rev. C. M. Ramus, from the Secretary of the Admiralty. Mr. Ramus, in 1872, suggested to the Admiralty the adoption, for the purpose of increasing speed, of the stepped bottom method of construction of vessels, a system which has since been adopted in practically all skimming boats. It was utilised in the coastal motor boats, a type of fast torpedo craft designed and developed during the war by Messrs. Thornycroft, an account of which, by Sir J. E. Thornycroft and Lieutenant Bremner, R.N., D.S.O., was given at the spring meetings of the Institution of Naval Architects, and reprinted in our issue of March 30, 1923, page 393. A description of the Ramus proposals and the interesting results of experiments carried out by Mr. W. Froude in connection therewith appeared in ENGINEERING of September 24, 1920, page 395. The Admiralty letter above referred to is as follows:—

"MADAM,—With reference to your letter of March 16 and previous correspondence regarding the investigations into the shape of hulls of high-speed boats conducted by your father, the Reverend C. M. Ramus, in 1872, I am commanded by My Lords Commissioners of the Admiralty to acquaint you that after careful consideration they found that it was not in their power to make any direct grant from the Navy Votes and that the only course open to them was to lay the facts before the Prime Minister with a view to a grant from the very limited resources of the Royal Bounty Fund. Their Lordships are now informed that the Prime Minister has been able to make a small grant of 200*l.*

"While regretting that a more substantial recognition of your father's services has not been practicable, their Lordships feel that, apart from the question of pecuniary reward, it may perhaps be a source of satisfaction to Mr. Ramus' family to be informed that in their Lordships' judgment it was only the fact that no light powerful machinery had been invented or developed until quite recent years that prevented your father's remarkable invention from being made use of for over thirty years, and that there is no doubt that to his investigation is due the credit of the stepped construction of coastal motor boats which played a notable part in the naval operations of the European War.

"I am, Madam, your obedient servant,

"(Signed) V. W. BADDELEY."

BRITISH IRON AND STEEL PRODUCTION.—The National Federation of Iron and Steel Manufacturers state that the production of pig-iron in October amounted to 592,600 tons, compared with 558,600 tons in September and 481,500 tons in October, 1922. There were 188 furnaces in blast at the end of the month, a decrease of 2 compared with the preceding month and a total decline of 35 since the end of May. The output of steel ingots and castings amounted to 702,100 tons, compared with 695,100 tons in September and 565,200 tons in October, 1922.

PORTABLE TAR-MACADAM DRYING AND MIXING PLANT.

CONSTRUCTED BY MESSRS. SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, OPENSHAW, MANCHESTER.

Fig. 1.

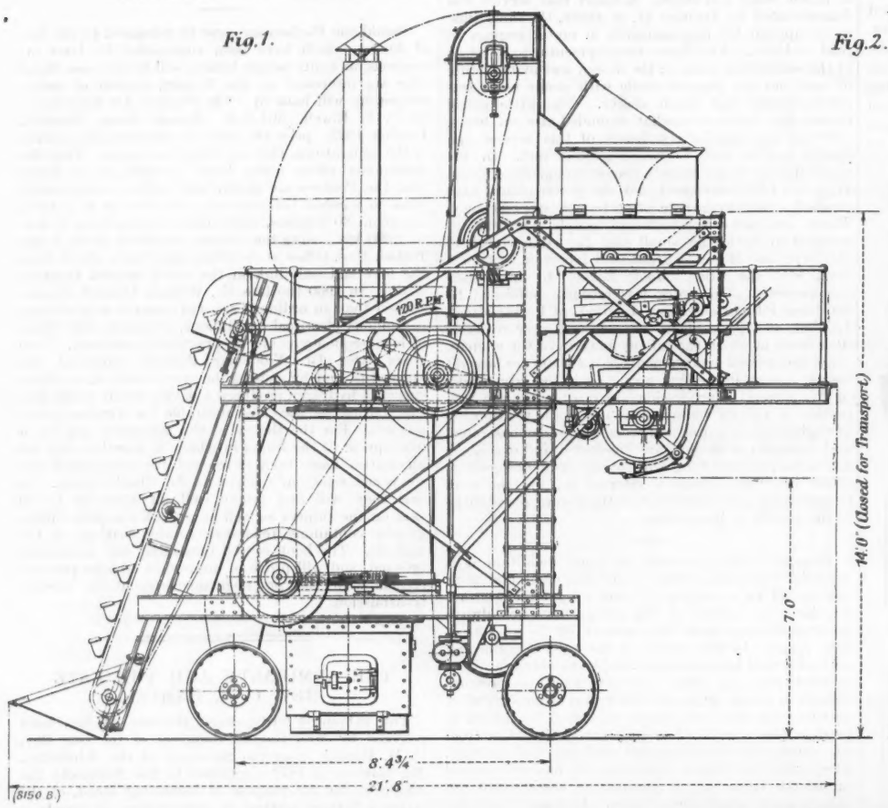
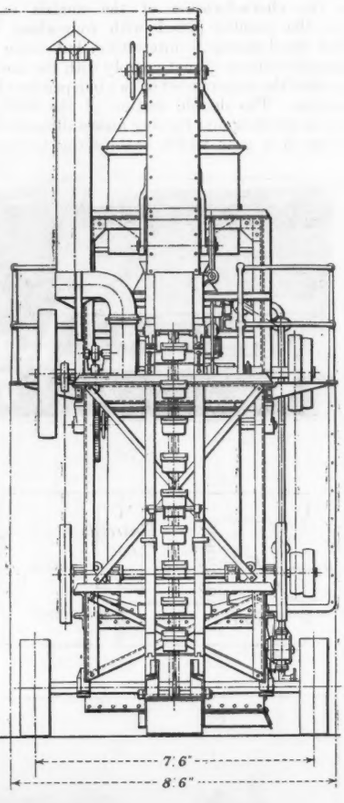


Fig. 2.



A PLANT embodying several unique and interesting features is illustrated in Figs. 1 to 5 on this and the opposite pages, which show the new portable tar-macadam drying and mixing machine of Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, Openshaw, Manchester. Figs. 1 and 2 give side and end elevations of this plant, a general view being given in Fig. 3 of a finished machine at the works. This, it may be pointed out, shows the opposite side from that depicted in Fig. 1. The two figures, Figs. 4 and 5, on the opposite page, show the drier, which is one of the unique features of the plant. The whole machine has been arranged with a special view to compactness which is often a great desideratum, while portability is assured by arranging the upper gear so that it can be hinged down, when a travelling height of about 14 ft. is obtained.

At one end of the machine is a hopper and bucket conveyor. This hopper is fed with the broken metal to be used in the preparation of the tar-macadam. The hopper, it will be noted in Fig. 3, is hinged so that it can be tilted up to clear the ground when travelling. The bucket conveyor lifts the material and delivers it into a chute leading, by way of a self-closing, weighted flap door, to the top of the drier. The drier is a vertical steel cylinder provided with a central shaft hung in a ball bearing at its upper end and guided at the bottom by a second, bushed, bearing as shown in Fig. 4. The upper bearing carries the whole of the weight of the drier and its contained load of metal. The drier is fitted inside with two helices of moderately small pitch and the material to be dried is fed on to these. The drum does not revolve, but a small oscillating motion is imparted to it by two spring-fitted connecting rods operated by eccentrics on a shaft carried on the main frame and driven by belt from the main shaft as shown in Fig. 1. The oscillation set up in this way and amounting to about 1 inch, gradually works the material down the sloping surfaces inside the drum to a discharge chute at the lower end. A brick-lined furnace is arranged under the main frame immediately below the drier, and a centrifugal fan on the upper platform and discharging to an uptake, draws the hot gases through it and over the material to be dried. The helical path adopted results in the gases and metal being in contact for a long period, so that effective drying is secured. In order to dry the material and raise it to the proper temperature under varying conditions, the period of treatment can be altered to suit the state of the metal by changing the rate of oscillation. This is done by the use of step pulleys for the belt drive. The drier is thoroughly protected by insulating material (magnesia block) and has sheet iron cleading.

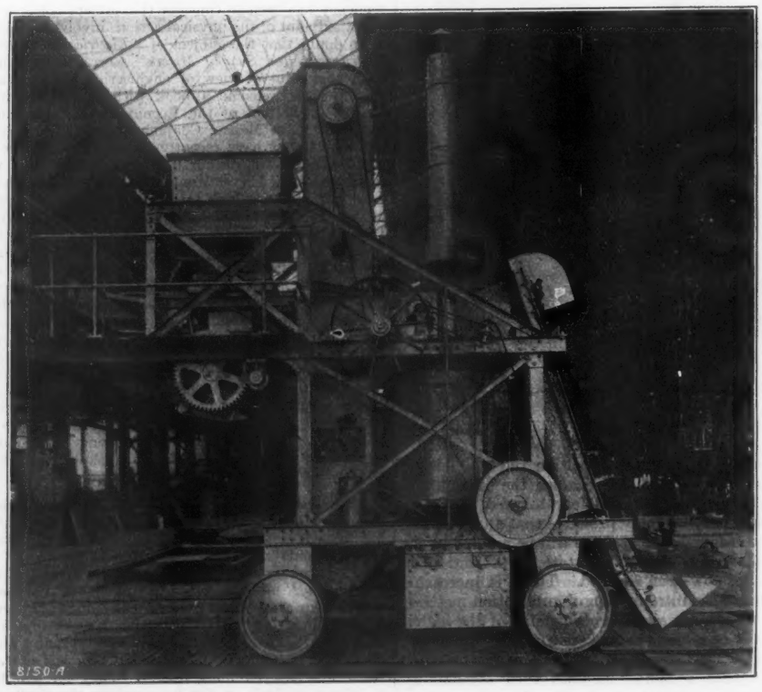


FIG. 3.

On discharge from the drier the material passes to the boot of a vertical bucket-elevator. This elevator raises and delivers it to a completely enclosed storage hopper on the high-level platform. The hopper is fitted with a sliding gate on rollers, by means of which the material is admitted to a weighing machine below. This machine has a steelyard and jockey weights, and is graduated to weigh to pounds, quarters and hundred-

PORTABLE TAR-MACADAM DRYING AND MIXING PLANT.

CONSTRUCTED BY MESSRS. SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED.

Fig. 4.

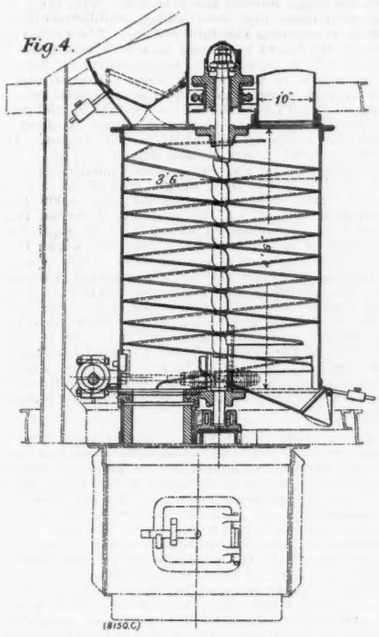
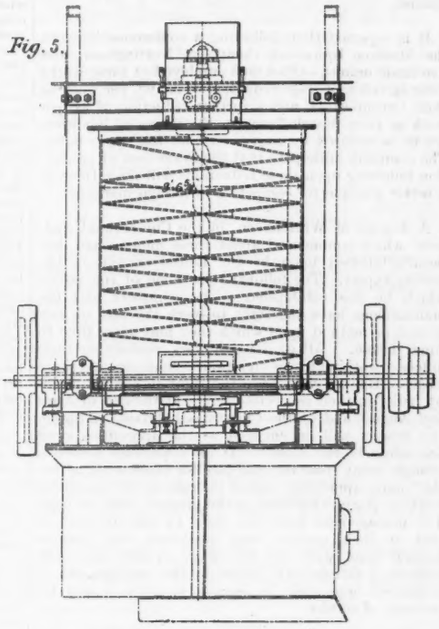


Fig. 5.



weights. A thermometer is fitted to the hopper so that the temperature of the metal to be delivered to the mixer may be checked and correctly maintained. From the weigher the material is dropped into the mixer immediately below. This appliance is of the revolving paddle type, different sets of arms being furnished to suit various qualities of material. As the blades are detachable they are easily renewed when worn. The shaft carries eight arms. It is driven by a large gear and pinion from a shaft worked off the main driving shaft by chain.

Tar is supplied from a separate tar boiler, from which it is drawn by means of a gear pump, also driven from the main shaft. The pump maintains a constant circulation of tar or binder, and delivers to a measuring trough on the operating platform where there is a control cock. The measuring trough is just above the mixer. It is mounted on trunnions, and when filled can be tilted so as to discharge the hot tar into the mixer on to the hot metal already received from the weigher. On its underside the mixer has a flap door which discharges from a height 7 ft. above ground level, so that a cart can be brought directly underneath it.

The main shaft is driven by belt from an independent power unit, or may be driven by electric motor or from an oil engine mounted on an extension of the main frame of the machine. The two elevators are chain driven from the main shaft. The whole plant can be operated from the platform by one man, the levers, &c., being brought together conveniently at this level.

The machine is mounted on four wide steel dished plate wheels, the front axle being made to swivel and being fitted with a draw bar. The main framing is of heavy rolled steel sections and the whole is substantially built. The type A machine is made portable as illustrated or can be arranged as a fixed plant. It has an output of 3 tons to 5 tons per hour. Larger sizes, of 9 tons and 13 tons per hour are also made of similar design, but arranged as fixed plants. The firm further makes larger sizes than these, but of other design.

As already stated the upper part of the gear can be lowered as indicated in Fig. 1, so as to reduce the height when moving from place to place, the whole of the upper part of the elevator trunk being swung down, as indicated by the dotted line, to the left, in Fig. 1. This movement is controlled by the worm and worm wheel shown.

In conclusion we may summarise some of the main points of the plant. The novel form of drier ensures a long contact of the hot gases with the material, within very moderate dimensions. It is claimed that the sliding movement, replacing the usual cascading, minimises the production of fine particles and dust, and that with a clean material no additional dust is produced in drying. The usual cyclone can therefore be dispensed with, though if regularly dealing with metal containing fine material a fan can be added at the outlet to draw this off. Provision is made for this. The storage hopper is completely enclosed from the weather, and the tar pump keeps up a constant circulation so that the binder is always at a suitable temperature. With regard to labour, one man can run the plant and a second is required to feed the first elevator. The furnace requires little attention and can be looked after by the man in charge of the tar boiler.

METALLURGICAL PROBLEMS.

THE "Sorby Memorial" Lecture, delivered by Dr. W. Rosenhain, F.R.S., on Friday the 9th inst., is an annual event held in Sheffield to commemorate the work of a great pioneer. The lecturer spoke on "Metallurgical Problems: Present and Future," and opened his remarks by saying that the research accomplished in the realm of scientific metallurgy during the past forty years should be used as a basis for fresh endeavour. He was not desirous of assuming the *role* of a prophet; his remarks on future developments were merely conjectures, and should be taken as such. Industry and science were gradually coming into closer contact and "rule-of-thumb" methods were fast disappearing.

Research activities were being carried out on a large scale in universities, although the time of the teaching staffs was limited. Government scientific institutions, such as the Research Department, Royal Arsenal, Woolwich, and the National Physical Laboratory, Teddington, were insufficient, and the important place held by metallurgy demanded the establishment of a research institution of its own. It was perhaps the wrong time to make such a suggestion for financial reasons, as the construction and endowment of an institution of this kind would probably cost a quarter of a million sterling. It would, however, sooner or later have to come into being. During the past few years many new alloys, both ferrous and non-ferrous, had been developed, and much new light had been thrown upon such questions as hardening and tempering. It often happened that a material was discovered and exploited on a commercial scale long before its inner history was known. Duralumin was a case in point; the valuable properties of this alloy were put to practical use eight or nine years before the interior constitution of the material was known. There was room and need for a large amount of research into the complex equilibria of alloy steels extensively used at the present time. The equilibria of the ternary systems of alloy steels were little known and those of the quaternary systems were not known at all. The lecturer viewed with satisfaction the establishment by the Royal Society of a committee to investigate the equilibria of the simpler ternary systems. This was but a beginning, the study of quaternary systems would follow. Practical men carried out experiments on a commercial scale and developed valuable alloys without knowing anything of their real properties. This was due to the fact that while manufacturers were often willing to spend money on experiments which might result in commercial gain, they would not spend it on research work for its own sake. This haphazard fashion of discovery was not satisfactory; the best alloys were undoubtedly discovered by scientific means.

Special steels consisted essentially of iron alloyed with proportions of other metals and variously heat-treated. Pure iron, however, was the main constituent. If it were possible to use a much stronger metal than iron as a base, and ascertain by scientific means the best methods of quenching and hardening, a material having a tensile strength of 1,200 tons per square inch might be the result. Using such an alloy, the turning of quartz and diamond would become mere child's play. Tungsten might prove to be the right metal; at the present time it was impossible to make tungsten alloys in large masses, as the melting point of the metal was higher than that of any known refractory. This operation, however, might be accomplished in the future, and the hardening effects of tungsten, if such could be obtained, would be ascertained. Possibly molybdenum, or tantalum, or vanadiun, and not tungsten, would give the desired results. Important alloys developed quite lately in industry were (1) the high-chromium "stainless" steels, (2) the cobalt magnet steels, and (3) an iron-nickel alloy (78·5 per cent. nickel, 21·5 per cent. iron), which, when properly treated, possessed a high magnetic permeability. At present it was impossible to explain the properties of these materials, this being entirely due to the fact that their fundamentals had not been studied sufficiently. It might be asked, continued the lecturer, that if such alloys gave good results, "Why bother to study their inner history?" The answer was that the valuable properties of materials could not fully be exploited by the haphazard methods employed. If we knew the internal mechanism of these alloys we could discover still more valuable properties.

Passing on to the subject of plastic deformation and fatigue, the lecturer recalled work carried out more than twenty years previously by Professor, now Sir Alfred, Ewing, and two of his students, Mr. J. C. W. Humfrey and himself. The "Ewing and Humfrey Attrition Theory of Fatigue" had, up till quite recently, been the acknowledged theory. Recent work by Hanson and Gough, however, had given birth to a new theory and was causing metallurgists to entirely review their opinions on fatigue. That the problem would occupy the minds of scientists for some time to come was quite certain. Investigations by means of "X"-rays had recently thrown much new light on atomic spacings, their arrangements, and all details appertaining thereto. The atomic substitution theory put forward by the lecturer in connection with solid solutions had been proved correct in the case of all metallic systems with the exception of that of iron and iron carbide. The small size of the carbon atom had proved a great difficulty and the problem was still awaiting definite solution. The distortion of the lattice system by various means and the behaviour of atoms during the cooling of liquid metal, involving what might be termed the polymerisation of molecules, were subjects dealt with at length by the lecturer. A most interesting question, stated to have occupied the minds of physicists for some time past, was that of the maximum cohesive strength of solids brought about by perfect inter-atomic attachment. Quite recently, Griffiths, at Farnborough, had prepared, under very special conditions, vitreous silica which possessed the enormous tensile strength of 200 tons per square inch and had an abnormally high elastic value. A rod of this material could be bent into the shape of a horseshoe and, when released, it sprang back and swayed from side to side before re-assuming its original position. That these wonderful properties had been brought about because perfect inter-atomic attachment had been obtained there could be little doubt.

Passing from the amorphous solid to metals, the lecturer stated that, if it were possible to manufacture steel in such a way that perfect cohesive strength could be obtained, coupled with the elimination of fatigue as we now know it, the resultant material would be extraordinary. It would possess immense strength, and the fact that it was no longer ductile would be compensated for by its elasticity, which would enable it to absorb shock like indiarubber. In conclusion, Dr. Rosenhain stated that the conquest of the sea and air had been successfully accomplished, but that, up to the present, we had been content to merely explore the surface of the earth. He made the striking statement that the time would in all probability come when, not content with merely scratching the surface of the earth and going down a few thousand feet, we would dig deep down into the interior of the earth's crust. This constituted a problem for the mining engineer. Few new metals would be discovered, but we might secure supplies of the rarer metals, such as tungsten and beryllium. The former, which up to a few years ago was a chemical curiosity, was now quite

commonplace and rapidly increasing in importance. Beryllium was one of the rare light metals; it was interesting and might prove useful; it possessed the density of magnesium coupled with a hardness similar to that of mild steel.

INDUSTRIAL NOTES.

As announced in our preceding issue, a conference between the employers and the United Society of Boilermakers and Iron and Steel Shipbuilders was held in London last Friday, but no decision was arrived at. The negotiations were resumed on the following day, last Saturday, and lasted over 12 hours. At the close, the following statement was made: "Various proposals and counter-proposals were submitted and discussed, and it was agreed by both sides to adjourn the conference until Wednesday, the 14th inst., at Edinburgh." No decision was reached, and at the close of the meeting the following official statement was issued: "The employers and the workers' representatives have been in conference all day. They have again given the whole question very full consideration, but have not yet reached finality in their deliberations. They have agreed to adjourn the conference until to-morrow (yesterday) morning."

The delay in arriving at a decision with regard to the miners' wages agreement may result in the South Wales Miners taking separate action, outside the Miners' Federation. They hold the view that even if the ratio of profits were altered to give the men more favourable results, they would not secure the living wage they desire. In South Wales, further trouble is constantly arising owing to non-unionist men being employed in the coalfields. At a conference held last week in Cardiff, the following resolution was passed in the matter of the Compensation Bill:—

"That having carefully considered the Workmen's Compensation Bill introduced by the Government, we most strongly protest against its provisions and urge upon the Government the necessity of inserting in the Bill the following amendments: (1) That in fatal cases the widow shall receive a sum of not less than 300*l.* and that each dependent child shall receive the sum of 10*s.* per week until the age of 15 years, and that any compensation paid between the date of the accident and death shall not be deducted from the lump sum; (2) that two-thirds of the average earnings be paid as compensation, such payment to be continued until suitable work has been provided by the employer; (3) that injured workmen shall be paid compensation from the date of the accident; (4) that men suffering from phthisis, tuberculosis, or silicosis, or any other disease which arose from the effects or is aggravated by the employment, shall be paid compensation."

The coalowners have been considering the demands made by the miners in modification of the wages agreement, particulars of which we gave in former issues, and it is expected that their reply, most probably an adverse one on all points, will be issued to-day.

The National Wages Board for the railways commenced its sittings in London last week, as announced on page 591 *ante*. The chair was taken by Sir William Mackenzie. At the first meeting, Mr. W. Clower, of the London, Midland and Scottish, stated the case on behalf of the companies, and said that now for the first time in the history of national negotiations, the combined railway companies were asking for a reduction in wages. Hitherto, all the applications had invariably come from the men, in the demands for higher wages or altered conditions. He urged that the railways had to be run on commercial lines; competition by road motor transport was increasing in intensity and seriousness every day. Mr. Clower also reviewed Sunday and night duty, and the work of various grades. He continued his remarks at the following meeting and established comparisons between the wages of road tramway drivers and of railway drivers. There were 150,000 railwaymen still in receipt of a war wage, of from 6*s.* to 7*s.* per week and over. It was indefensible, Mr. Clower said, in conclusion, to continue the anomalies which now existed between the various grades, particularly when standardisation had become the battle cry. At the adjourned meeting on Tuesday last, Mr. Clower was cross-examined by several railway trade union representatives; the meeting was further adjourned to last Wednesday, when Mr. Cramp and other trade union representatives put before the Board the views from the point of view of the unions. The sittings are being continued.

Mr. Frederick C. Tilley, speaking recently at the half-yearly meeting of the Society of British Gas Industries, said that a matter which required to be most carefully watched was that of railway rates. It was only fair that too much should not be expected at once in the way of economies by the grouping of the railways, but all possible pressure should be exerted for bringing railway goods rates into closer relation with present-day needs. Nothing that retarded the recovery of the country's trade should be overlooked, and any tendency to give preferential treatment to railways must be guarded against.

It is reported that, following a conference between the Stanton Ironworks Company, Nottingham, and five trade unions, skilled men employed at these works have agreed to a wage reduction of 3*s.* 6*d.* per week as from December 31, and a further reduction of 3*s.* per week as from March 3 next; the wages of labourers are to be reduced by 1*s.* 6*d.* on both the above dates. The company anticipate that the lower cost of production following upon these reductions will place them in a better position for competing in foreign markets.

A dispute at Whitehaven, in the Cumberland coalfield, which commenced about three months ago, has been arbitrated upon by Sir Lowes Dickinson, the mining expert. The following are some of the points which he has established:—The company and the management have the right to work the pits by any system or method upon which they may from time to time decide. All qualified hewers working in their different working places on all shifts shall join and share wages. Hewers shall have the right to change places by ballot in their respective seams at the end of April and August and at the Christmas holidays. Apprentice hewers will be engaged at the apprentice rates prevailing in the county. If an apprentice hewer is brought away from the coal face for other work, either the county apprentice rate or the rate for the particular working place, whichever is the greater, shall be paid. The management have the right to test any tub of coal at their option. Any workman who absents himself from work for two days in any one week without a satisfactory reason to the management or a doctor's note shall be deemed to have broken his contract of service.

The secretary of the General Federation of Trade Unions, in the report to September 30, now issued, refers to the loss in trade union membership and states that unemployment accounts for much of it, but for nothing like the whole. Between 1921 and 1923, the Trade Union Congress reported a falling-off in membership of 2,048,647, whilst the unemployed total at the time of writing was 1,344,667. Not all the unemployed had left their unions, nor had numbers of the unemployed ever been trade unionists. Therefore of the balance between the two totals, 703,980, only a portion represented those who had fallen out of the unions through unemployment. The present position appeared to be that something like a million people had left the trade unions for causes which were not openly or directly attributable to unemployment. Some who had withdrawn from the unions said they could not afford to pay the contribution and would rejoin when trade was better. Others declared that there was now no need to belong to trade unions, since unemployment and sickness benefits, and some disputes were dealt with by Government Departments. There were numbers who said that the trade unions could not do the many things promised on their behalf, and others who complained that the big amalgamations of dissimilar occupations had destroyed personal relationship and touch with technical detail. The charge of diminished usefulness was an exasperating one for those who foresaw the danger, if not the extent, of bureaucratic usurpation of trade union functions. It was doubtful whether this generation could now devise means of escape from the state of things which thoughtlessness on the one hand and ambition on the other hand brought about. There was dissatisfaction at the disappearance in many cases of the old personal relationships between officials and members.

At the end of October notices were posted in six of the seven merchant bar mills at the Duquesne, Pa., steel works of the Carnegie Steel Works, that one shift of men will be eliminated forthwith, says *The Iron Age*, New York. This will reduce employment by one-third in these mills, and it is the first retrenchment by the Steel Corporation in the Pittsburgh District. There have been three shifts of 8 hours each. The shift from 11 p.m. to 7 a.m. has been eliminated. This group is known as the lower works of the Duquesne plant.

American-Canadian Electricity Merger.—According to *The Iron Age*, New York, the General Electric Company, Schenectady, N.Y., has perfected plans for a merger with the Canadian General Electric Company, with plants at Toronto and Peterboro, Ont., which hitherto has operated under an agreement to manufacture equipment of the former company in Canada. The acquisition includes the Canadian Allis-Chalmers Company, manufacturers of electrical equipment, with works at Toronto, Bridgeburg, Stratford and Montreal. Expansion will be carried out at the different plants by the American organisation.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Iron and Steel.—The upward movement in trade finds expression in the further absorption of unemployed and the putting into commission of a certain amount of plant which for many months has been idle. This does not mean to indicate that steel-making establishments are working at anything like full capacity. Indeed, having regard to the record extensions that have been made to plant, it will be necessary to secure orders far beyond the magnitude of the pre-war boom period to enable plant to work continuously. The latest official returns of iron and steel production in the Sheffield district show that during September the gross output declined to 83,000 tons, compared with 94,000 tons in August. The September total, however, was 12,000 tons in excess of the aggregate for the corresponding month last year. More than half the total output was of basic steel, Bessemer acid steel accounting for only 4,000 tons. Lincolnshire output, on the contrary, increased from 38,000 tons in August to 48,000 tons in September. The whole of this was of basic steel, the works there having been employed at not far short of full capacity. Big business on railway account is anticipated in the new year. Already there is an improvement in railway stores, axles, wheels, tyres and certain classes of engineers' tools. Buyers of crucible and high-class tool steels have now been thrown back upon current production by the final absorption of war stocks, the last thousand tons having been disposed of abroad. The tool trades are working rather more regularly. Some nice orders have this week been booked for joiners' and colliers' tools, and builders' ironmongery.

South Yorkshire Coal Trade.—Market conditions are somewhat mixed. The increased shifts worked at many collieries in order to cope with the improved demand has resulted in an accumulation of smalls, which on the average are 1*s.* 6*d.* per ton cheaper. On the other hand the maintenance of a healthy call on export account, coupled with the brighter outlook in the home manufacturing industries, has caused best steams to appreciate 1*s.* per ton. There is a prompt market for bunker fuel. Cobbles and nuts are firmly maintained at recent rates, but inferior slacks are on offer below listed quotations. Virtually the whole output of best house coal is going away on contract account. Spot purchases are confined to secondary qualities. Quotations:—Best handpicked branch, 31*s.* 6*d.* to 32*s.* 6*d.*; Barnsley best Silkstone, 27*s.* 6*d.* to 29*s.*; Derbyshire best brights, 27*s.* to 29*s.*; Derbyshire best house coal, 23*s.* to 24*s.*; Derbyshire best large nuts, 21*s.* to 22*s.* 6*d.*; Derbyshire best small nuts, 15*s.* to 16*s.*; Yorkshire hards, 21*s.* to 23*s.*; Derbyshire hards, 20*s.* to 22*s.*; rough slacks, 11*s.* 6*d.* to 13*s.* 6*s.*; nutty slacks, 10*s.* to 12*s.*; smalls, 5*s.* to 8*s.*

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Scottish Steel Trade.—Little change of any kind has taken place in the steel trade of Scotland during the past week. Buyers are not placing many forward orders at the moment, and business all round will be much upset now that a General Election is so close at hand. It will certainly be an advantage that the contest will not be long drawn-out, but that it will be short and sharp, and that the dislocation to business will be the minimum. Inquiries have been fairly satisfactory of late and there are prospects of some improvement in the demand in the near future. Industry is waiting patiently on the return of the boilermakers to work, and much depends on the result of to-day's meeting in Edinburgh. Should an amicable agreement be reached and it be decided that work be resumed forthwith, a big impetus will be given to general trade. Meantime the shipyards remain idle, and the steel works partly so. In the black-sheet trade the position is almost unaltered, and while there is still a good demand for thin sheets the heavier gauges, although slightly better, show little change. Prices are steady and are as follow:—Boiler plates, 13*l.* per ton; ship plates, 10*l.* per ton; sections, 9*l.* 15*s.* per ton; and sheets, 12*l.* 10*s.* per ton, all delivered Glasgow stations.

Malleable Iron Trade.—In the West of Scotland malleable iron trade a better tone is noticeable and there has been a little improvement in buying. For re-rolled steel bars the demand continues very good, and fairly active conditions are general. Prices are unchanged, with "Crown" bars at 12*l.* per ton delivered Glasgow stations.

Scottish Pig-Iron Trade.—While the demand for Scottish pig-iron is still somewhat slow the outlook is a shade better. Sales for immediate delivery are not heavy, with the result that stocks are not visibly decreasing. Prices are steady and are as follow:—Hematite, 5*l.* 5*s.* per ton, delivered at the steel works; foundry iron, No. 1, 5*l.* 5*s.* per ton, and No. 3, 5*l.* per ton, both on trucks at makers' yards.

Shipments of Scottish Pig-Iron.—The shipment of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, November 10, amounted to 1,344 tons. Of that total, 1,150 tons went foreign and 194 tons coastwise. For the corresponding week of last year the shipments were 4,325 tons overseas and 257 tons coastwise, making a total of 4,582 tons.

Clyde Shipbuilding.—It is understood that several shipbuilders in the Clyde area have recently booked one or two fresh contracts which have not yet been reported. One order which is now public is of some importance because it means the re-opening up of a yard which has been closed completely since the end of 1921—that of Messrs. Yarrow and Co., Scotstoun. The latter have fixed up to build a large shallow-draught river

steamer for the Anglo-Saxon Petroleum Company, for service on that part of the Yangtze-Kiang that lies between Ichang and Chungking, where navigation is rendered both difficult and dangerous by the many whirlpools and rapids that have to be encountered. This new vessel is for carrying oil fuel in bulk, and will be fitted with two sets of triple-expansion engines to give a total of 3,000 i.h.p., steam being supplied by two of the latest type of Yarrow patent water-tube boilers suitable for oil burning.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—Exports of coal as cargo from South Wales in October, when there were 27 working days, compared with 25 in September, amounted to 2,604,624 tons, an increase of 331,000 tons over the previous month and only 110,000 tons less than the record attained in May last. The daily rate of shipment at 96,470 tons also showed an improvement of 5,520 tons per day. Shipments from Cardiff totalled 1,565,086 tons, or 84,237 tons more than in the corresponding month of a year ago, from Newport 489,994 tons, an increase of 80,256 tons; from Swansea 295,962 tons, an improvement of 19,448 tons; and from Port Talbot 219,250 tons, an advance of 21,931 tons; but the Llanelly total, at 34,332 tons, showed a decrease of 7,165 tons. Shipments to France amounted to 1,007,490 tons, or 214,512 tons more than in October of last year; to Italy 493,294 tons, an increase of 92,860 tons; to Spain, 139,440 tons, an increase of 27,282 tons; to Greece 22,713 tons, an increase of 12,651 tons; and to other countries 406,187 tons, an increase of 69,740 tons. Exports to South America, at 271,420 tons, showed a reduction of 32,738 tons, and to Portugal, at 60,437 tons, a decrease of 3,023 tons. Generally the undertone of the coal market is steadier, and there are fewer weak spots than has been the case for some time past. This is due to the fact that tonnage has arrived more freely of late and placed colliery salesmen in a better position. Chartering, too, has been active of late, and the prospects are that there will be congestion in the near future. Everything, however, depends on the weather. Most of the collieries are well sold on paper, and should shipping come up as anticipated there will be little free coal available, but this cannot be counted on. For forward delivery a fair amount of business continues to be transacted, and sellers in practically all cases are not inclined to modify their prices. In fact, the tendency is to quote higher levels. For immediate shipments best Admiralty large rules from 28*s.* to 28*s.* 6*d.*, with Monmouthshires from 26*s.* to 27*s.*, but for forward business the former are firm at 28*s.* with the latter steady at 27*s.* Best steam smalls for prompt loading are firm at 18*s.* to 19*s.*, outputs having been reduced by the frequency of temporary pit stoppages, with other grades from 14*s.* to 17*s.*, according to quality.

Iron and Steel.—There is a good demand for Welsh tin-plates, and it is expected that the minimum price will shortly be advanced. The Stabilisation (Prices) Committee have decided to extend the principle of the fixing of prices for another twelve months, and this decision has given much satisfaction to makers as it gives security to the market. Orders have already been placed at well over the minimum price of 23*s.* 1½*d.* per basis box for delivery up to June next, and the demand is still active and widespread. Exports last week created a record for the current year amounting to no less than 25,010 tons, of which tin-plates and terne plates comprised 15,969 tons compared with 7,038 tons a week earlier; black plates and sheets, 5,965 tons, against 9,453 tons; galvanised sheets, 1,381 tons, against 634 tons; and other iron and steel goods, 1,695 tons against 1,797 tons.

"THE DROP-FORGER."—The issue for the present month of this journal, published by the Association of Drop Forgers and Stampers, Birmingham, contains two interesting and well illustrated articles on the "Flow of Metal during Forging," by Mr. H. F. Massey and Mr. L. A. Danse. It opens with editorial remarks on Continental—mostly German—competition and on the bad state of trade in this country.

"LE MONDE INDUSTRIEL."—Commencing with October, the Société Industrielle du Nord de la France, Lille, will publish monthly their proceedings under the above title. The monthly issue will also comprise the former publication entitled *Le Monde Textile*. Besides reports on the society's meetings, a large number of statistical and other data on the various industries of Northern France, Belgium and other countries will be given.

RETURN OF C.S. "FARADAY" FROM HER MAIDEN VOYAGE.—The new cable steamer Faraday, belonging to Messrs. Siemens Brothers and Co., Limited, of Woolwich, of which a description was given in our issue of July 27 last, has now returned from her maiden cable-laying expedition. She has successfully completed the laying of the section of cable connecting New York and Canso, Nova Scotia, about 1,000 miles; notwithstanding the fact that she encountered exceptionally bad weather, during which a mishap occurred to the cable and the end was lost in 3,000 fathoms of water. The end was recovered very quickly, and the whole section completed to the satisfaction of the engineers of the Commercial Cable Company, who have had it in continual use since laying. This section forms a part of the Commercial Cable Company's new cable connection between America and England, which has the greatest traffic-carrying capacity of any existing cable.

NOTICES OF MEETINGS.

THE CHEMICAL ENGINEERING GROUP OF THE SOCIETY OF CHEMICAL INDUSTRY.—Friday, November 16, at 8 p.m., at the Chemical Industry Club, 2, Whitehall Court, S.W. 1. "A New Source of Potash and its Industrial Exploitation," by Professor J. W. Hinckley.

THE INSTITUTE OF METALS; SWANSEA LOCAL SECTION.—Friday, November 16, at 7.15 p.m., in the Metallurgical Department, University College, Singleton Park. Paper on "The Density of Alloys," by Professor Thomas Turner, M.Sc., A.R.S.M., F.I.C.

THE WEST BROMWICH ENGINEERING SOCIETY.—Friday, November 16, at 7.30 p.m., at the Technical School, "The Application of Science to Industry," by Dr. C. M. Walter, A.M.I.E.E.

THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Friday, November 16, paper on "Essential Factors of Ship Propeller Design," by Mr. A. F. Ainslie.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, November 16, at 6 p.m., at Storey's Gate, St. James' Park, S.W. 1. Paper on "The Possibilities of Mercury as a Working Substance for Binary Fluid Turbines," by Mr. William J. Kearton, M.Eng.

THE DIESEL ENGINE USERS' ASSOCIATION.—Friday, November 16, at the Institution of Electrical Engineers, Victoria Embankment, W.C. 1. "Some Considerations Affecting the Choice of a Heavy Oil Engine," by Mr. Geoffrey Porter.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, November 16, at 7.30 p.m., at 39, Victoria-street, S.W. 1. Annual General Meeting. Saturday, November 17, at 2 p.m., visit to the Carriage Repair Depot of the Underground Railway, Acton Works, Chiswick. Friday, November 23, at 7.30 p.m. Lecturette. "Technical Arbitrations," by Mr. W. A. Tookey, M.I.Mech.E. (Past-Chairman).

THE BRADFORD ENGINEERING SOCIETY.—Monday, November 19, at 7.30 p.m., meeting in the Hall of the Technical College. Mr. R. B. Davis, B.Sc. (of London), on "The Control of Combustion in Boiler Plants," illustrated by lantern slides.

THE INSTITUTION OF CIVIL ENGINEERS; NEWCASTLE-UPON-TYNE ASSOCIATION.—Monday, November 19, at 7.30 p.m., at the Lecture Theatre, Neville Hall, Newcastle-upon-Tyne. Presidential Address by Mr. D. Balfour, O.B.E., M.Inst.C.E.

THE ROYAL SOCIETY OF ARTS.—Monday, November 19, at 8 p.m.: Cantor Lecture, "The Cultivation of Cocoa in British Tropical Colonies," by Mr. Samuel Henry Davies, M.Sc., F.I.C. (Lecture II). Wednesday, November 21, at 8 p.m.: Ordinary Meeting, "Forgeries of Ancient Stained Glass," by Mr. J. A. Knowles. The Right Hon. the Earl of Crawford and Balcarres, K.T., P.C., F.S.A., will preside.

THE INSTITUTE OF MARINE ENGINEERS, INCORPORATED.—Tuesday, November 20, at 6.30 p.m., "Reversing Systems to Large Marine Oil Engines," by Miss V. Holmes, B.Sc.

THE INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—BURNLEY SECTION.—Tuesday, November 20, at 7.15 p.m., at the Municipal College, Ormerod-road, Burnley. "The Founding of Admiralty Gun-Metal and Allied Alloys," by Mr. F. W. Rowe.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, November 20, at 7.30 p.m., at Rankine Hall, 39, Elmbank-crescent, Glasgow. Discussion on "Auxiliary Machinery for Diesel-Engined Vessels," by Mr. Robert Love; "Pipe Bending by Machinery," by Mr. Carl R. H. Bonn.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, November 20, at 6 p.m. Ordinary Meeting. Papers to be submitted for discussion: "The Effect of Groyning on Some Parts of the English Coast," by Mr. Richard Frye Grantham, M.Inst.C.E.; "The Tides from an Engineer's Standpoint," by Mr. Edward William Hollingworth, M.A., M.Inst.C.E.

THE MIDLAND INSTITUTE OF MINING, CIVIL AND MECHANICAL ENGINEERS.—Tuesday, November 20, at 2.30 p.m., at the Queen's Hotel, Leeds, when the Presidential Address will be delivered by Mr. John Brass, and the following papers will be open for discussion: "American Coal Mining," by Mr. J. A. S. Ritson; "The Position of Mechanical Engineering in Colliery Operations," by Sir William Ellis, G.B.E., D.Eng., M.Inst.C.E.

THE ROYAL METEOROLOGICAL SOCIETY.—Wednesday, November 21, at 5 p.m., at 49, Cromwell-road, South Kensington, the following papers will be read: (1) "Attempts to Measure Air Temperature by Shooting Spheres Upward," by Mr. L. F. Richardson, B.A., F.Inst.P.; (2) (*a*) Colonel H. G. Lyons, F.R.S., will exhibit a replica of an early Korean rain-gauge; (*b*) Mr. F. J. W. Whipple will exhibit a limit gauge for rainfall; (3) "On the Distribution of Air Density over the Globe," by Mr. S. N. Sen, M.Sc.

THE SOCIETY OF GLASS TECHNOLOGY.—Wednesday, November 21, at 2.30 p.m., in the Lecture Room of the Department of Coal Gas and Fuel Industries, The University, Leeds, to receive and discuss the following papers: (*a*) "Note on the Influence of Rapid Chilling on the Reversible Expansion of Clay," by Mr. H. S. Houldsworth, M.Sc.; (*b*) "Glasshouse Pots: Some Notes on their Manufacture and Use," by Mr. P. Marson; (*c*) "The Casting Process for Glasshouse Refractories in German Glass Plants," by Professor Kurd Endell.

THE INSTITUTION OF PRODUCTION ENGINEERS.—Wednesday, November 21, at 7.30 p.m., at the Engineers' Club, Coventry-street, W. 1. "The Use of Charts in Engineering," by Mr. A. W. Swan, B.A.Sc.

THE ASSOCIATION OF DROP-FORGERS AND STAMPERS.—Wednesday, November 21, at 7.30 p.m., in the Assembly Hall, Chamber of Commerce, Birmingham. Lecture. Drop-Forging Practice No. 3, "Clipping and Clipping Tools," by Dr. Leslie Aitchison, D.Met., B.Sc., A.I.C.

THE INSTITUTION OF ELECTRICAL ENGINEERS: WIRELESS SECTION.—Wednesday, November 21, at 6 p.m., in the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. "Periodic Tripper Reception," by Mr. E. V. Appleton, M.A., D.Sc., and Mr. F. S. Thompson, B.A.; "A Dynamic Model of a Valve and Oscillating Circuit," by Mr. R. C. Clinker, M.I.E.E.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, November 22, at 6 p.m., in the Lecture Theatre of the Institution. Joint Meeting with the Société des Ingénieurs Civils de France (British Section), "The Electrification of the Midi Railway," by Monsieur A. Bachellery.

THE INSTITUTION OF LOCOMOTIVE ENGINEERS (LONDON).—Thursday, November 22, at 7 p.m., at the Engineers' Club, Coventry-street, "Locomotive Shed Layout," by Mr. F. W. Attock, Member of Council.

THE BIRMINGHAM METALLURGICAL SOCIETY.—Thursday, November 22, at 7.15 p.m., at the Assembly Room, Chamber of Commerce, Birmingham, a paper will be given by Sir W. H. Bragg, K.B.E., F.R.S., D.Sc., "X-Ray Analysis of Metals."

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Supply of Cleveland pig-iron is still very limited, but promises to be increased in the near future by the restarting of one or two idle blast furnaces. Values are well maintained and a gratifying feature is the disposition shown to negotiate for forward business. Sales at current quotations are reported for delivery up to next April. Most of the business doing is for home use, but a little trade is passing with Continental customers. No. 1 is 107*s.* 6*d.*; No. 3 g.m.b. is fully 100*s.*; No. 4 foundry, 99*s.*; and No. 4 forge, 97*s.* 6*d.*—all f.o.t. makers' works, and f.o.b. Tees.

Hematite.—Continued comparatively low prices of East Coast hematite are inducing buying in quarters that usually draw upon Cleveland pig-iron makers for supplies. The steadily increasing demand is met by ample supply. Further sales to local users, to the Sheffield district, to Wales, and to the Continent have occurred and values are very strong. One or two home contracts have been arranged for delivery over the first half of next year. The minimum quotation for Nos. 1, 2 and 3 is 100*s.*, both for home and export trade, and some makers ask and report they have sold at a little above that figure. No. 1 is 101*s.*

Foreign Ore.—There is very little doing in foreign ore, but prices are a little stiffer. Best rubio is put at 23*s.* c.i.f. Tees.

Blast-Furnace Coke.—Quite a slump in the export price of coke, owing to loading difficulties on northern rivers throwing supplies on the market, has cheapened prices to local consumers, who report that they can now place orders for good average qualities at 36*s.* 6*d.* and rather less, delivered. As low as 34*s.* is stated to have been accepted.

Manufactured Iron and Steel.—Finished iron and steel producers are now in a fairly strong position. Quite a number of good orders have been distributed, and substantial inquiries are still in the market. Prices, all round, are extremely stiff, but have not been actually advanced. The following, however, are absolute minimum quotations:—Common iron bars, 12*l.*; iron rivets, 14*l.*; packing (parallel), 8*l.* 10*s.*; packing (tapered), 11*l.* 10*s.*; steel billets (soft), 9*l.*; steel billets (medium), 10*l.*; steel billets (hard), 10*l.* 5*s.*; steel boiler plates, 13*l.*; steel ship, bridge and tank plates, 9*l.* 15*s.*; steel angles, 9*l.* 5*s.*; steel joists and heavy sections of steel rails, 9*l.* 10*s.*; fish plates, 12*l.*; black sheets, 14*l.* 5*s.*; and galvanised corrugated sheets, 19*l.* 5*s.*

COAL DUST EXPLOSIONS IN THE OPEN.—Two coal dust explosions in the open have come to the knowledge of the United States Bureau of Mines, the lessons of which may prove of interest to a wider section of industry than that to which they actually relate. The explosions in question occurred at colliery dumps in south-eastern Iowa. In this part of the country coal is mined on the long-wall system. The men are paid on the screened coal, and therefore use forks for loading. The dust remaining in the workings is removed and deposited in dumps in the open. These dumps often fire and the burnt material is delivered to railways, &c., for ballast, road material and so on. The two explosions were found to have occurred during the removal of this by excavators, shots to break down the dump resulting in newly-deposited dust being thrown on to debris in the act of burning. The explosions produced burning clouds hundreds of feet in length, which resulted in each case in fatal injury to three men and less severe hurt to others. The importance in dealing with burning coal dumps of keeping the material well wetted is emphasised.

THE USEFUL LIFE OF AMERICAN LOCOMOTIVES.

(*For Description, see Page* 609.)

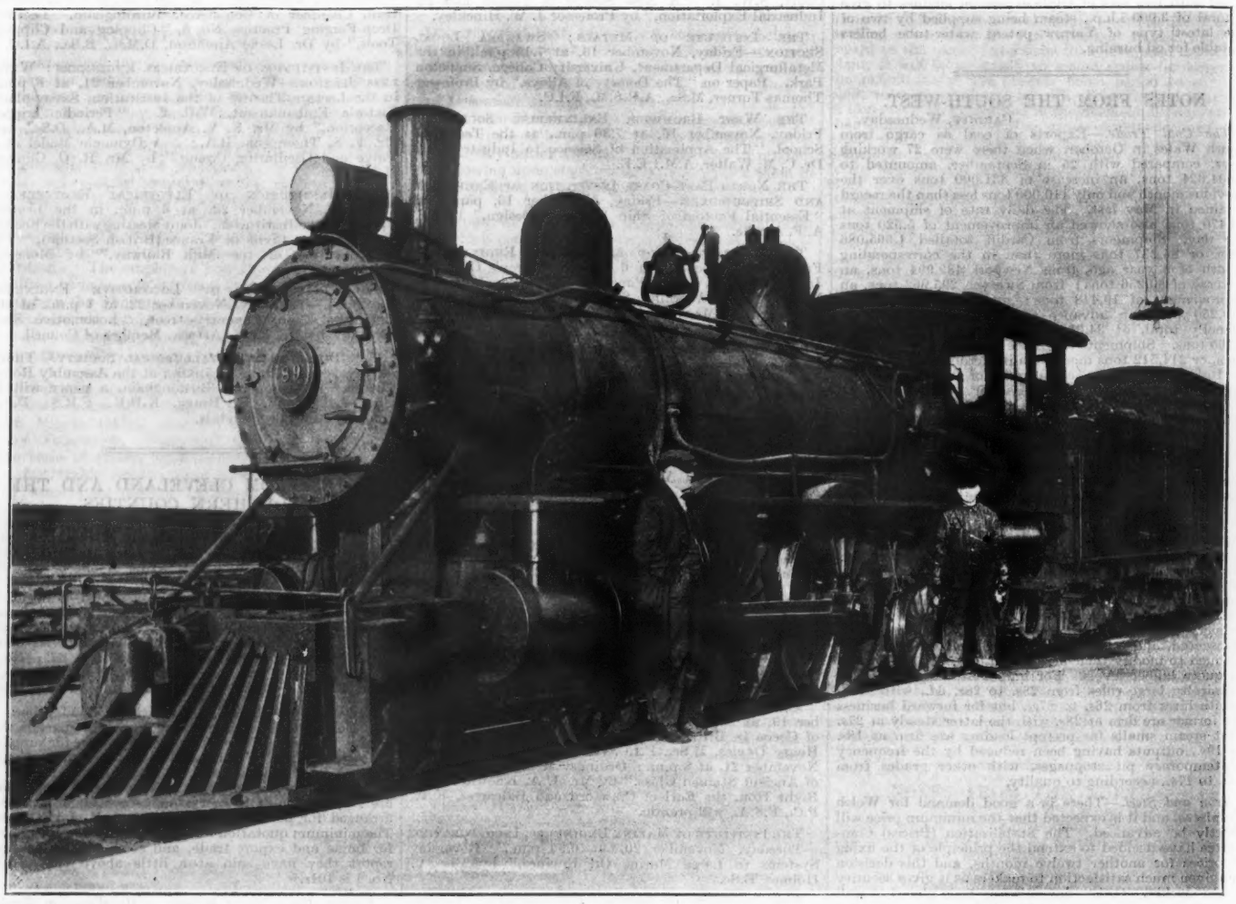


Fig. 3. One of the Original "Atlantic" Class with a Record of over 1,400,000 Miles.

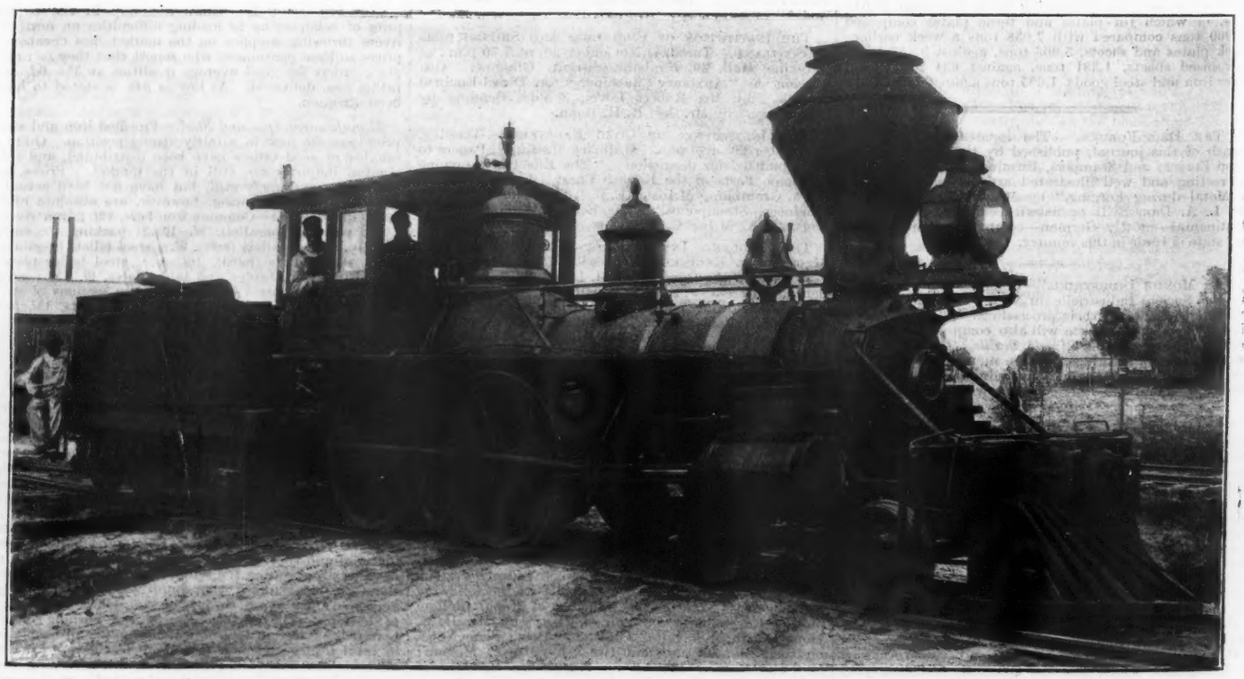
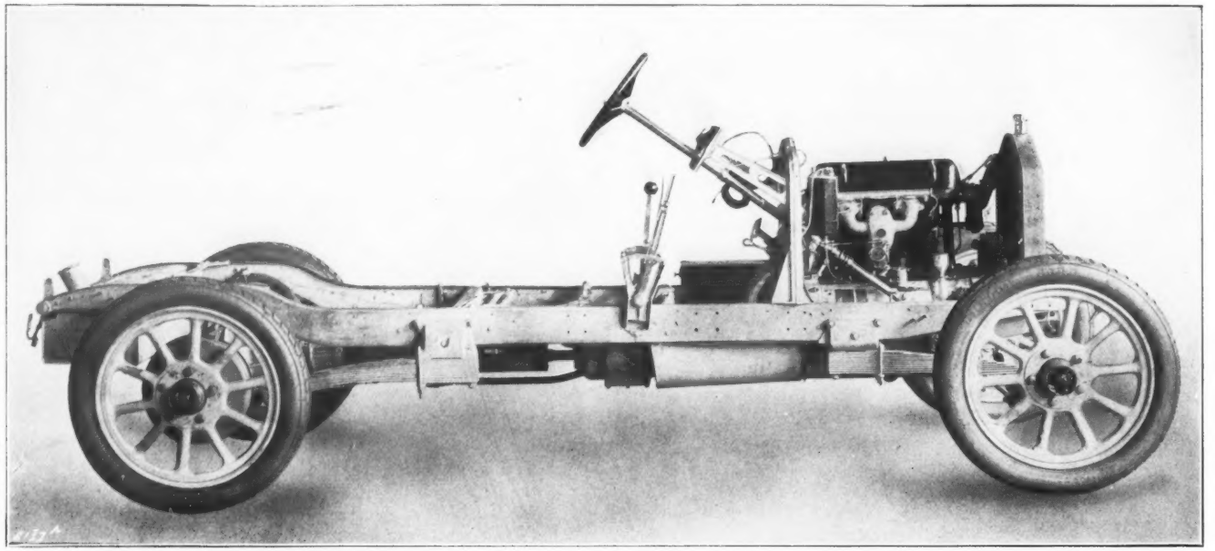


Fig. 4. Baldwin Locomotive Built in 1856 and still in Service

15-HORSE-POWER WOLSELEY MOTOR CAR AT THE OLYMPIA EXHIBITION.

CONSTRUCTED BY WOLSELEY MOTORS LIMITED, ADDERLEY PARK, BIRMINGHAM.

(*For Description, see Page* 613.)



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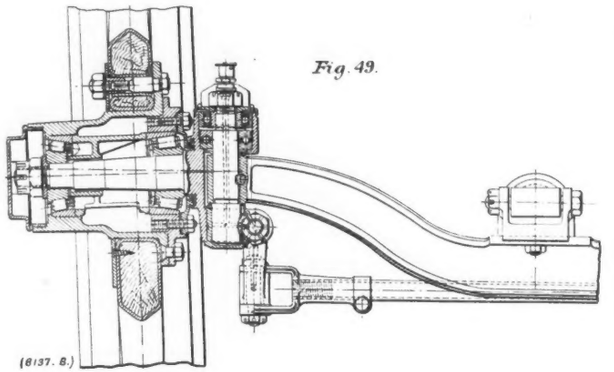

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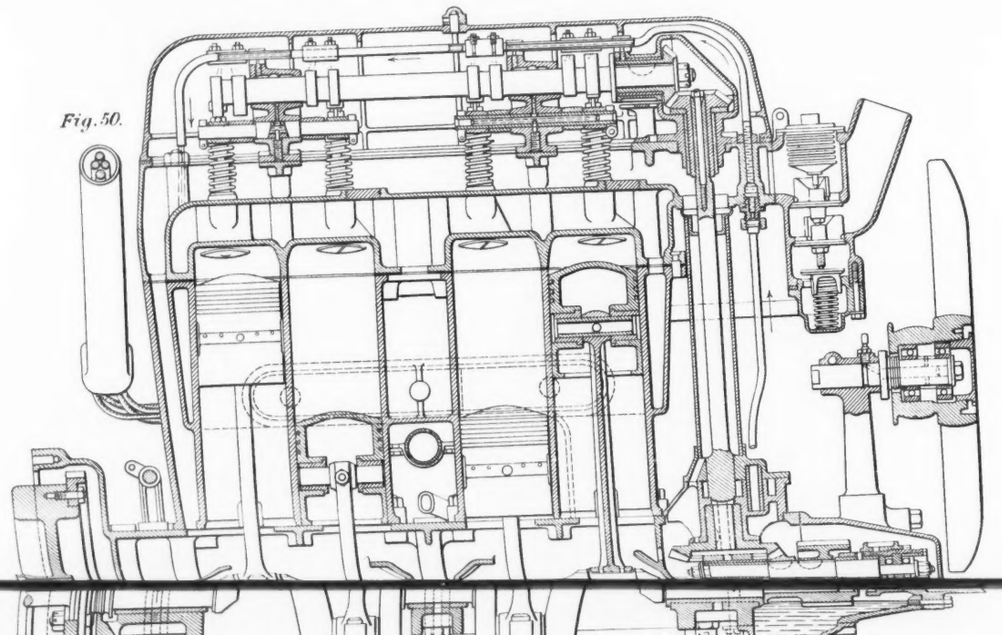

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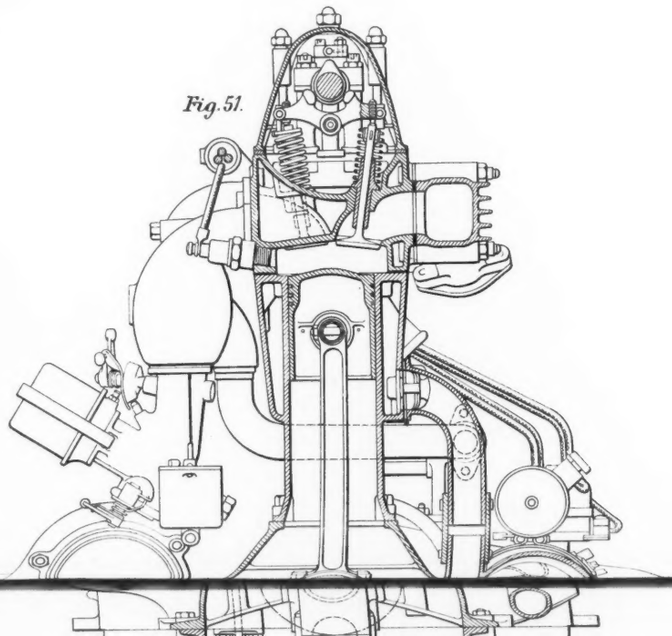

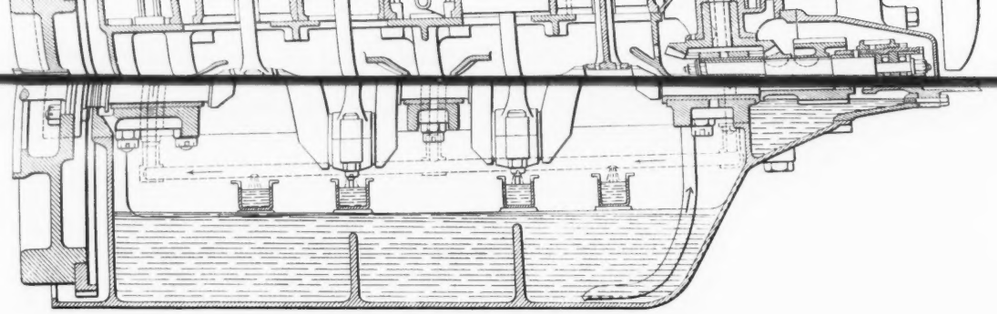

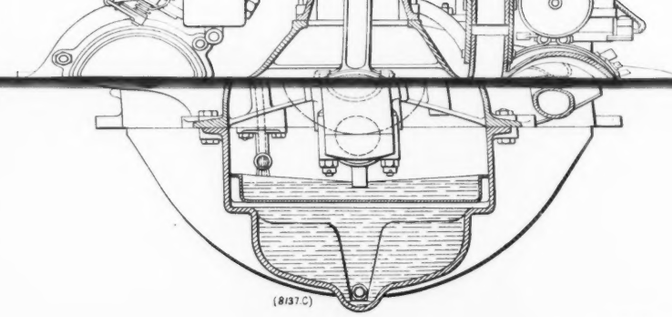

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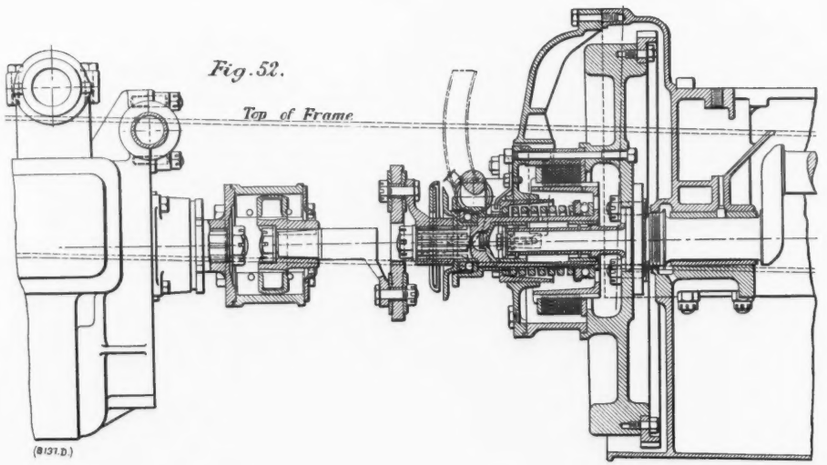

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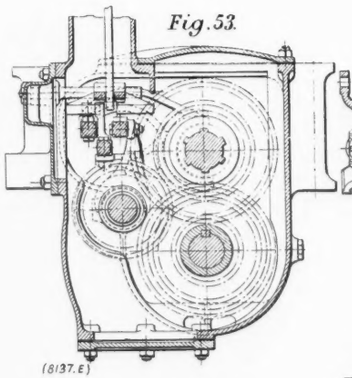

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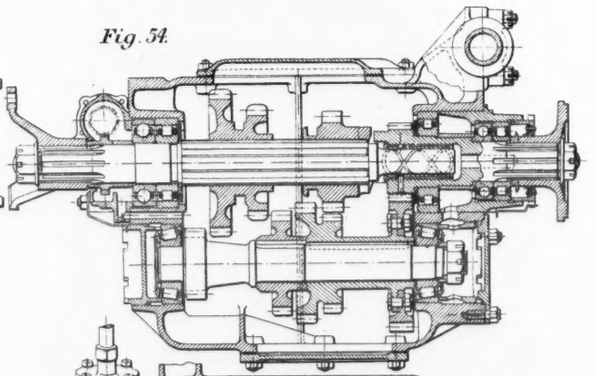

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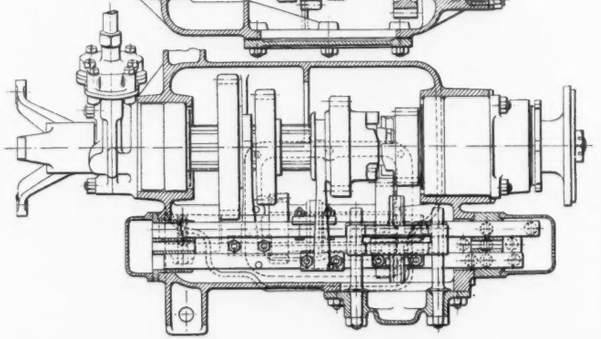

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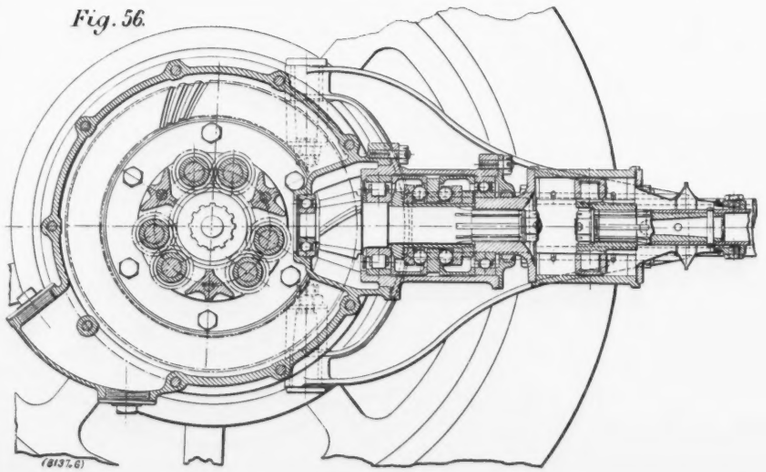

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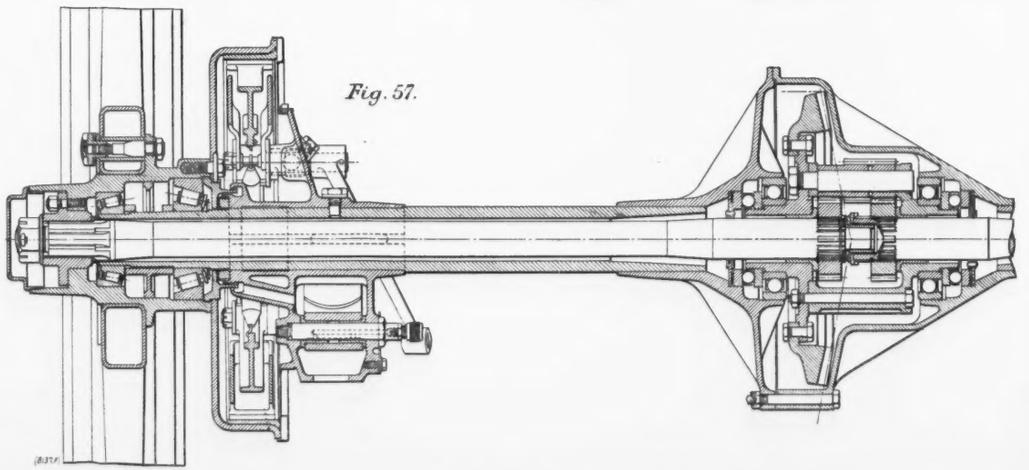

ENGINEERING.

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TIME FOR RECEIPT OF ADVERTISEMENTS.

Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity of going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication.

All accounts are payable to ENGINEERING, LTD. Cheques should be crossed "The National Provincial and Union Bank of England, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford-street, Strand, W.C. 2.

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ENGINEERING.

FRIDAY, NOVEMBER 16, 1923.

THE LIMITATIONS OF A RESEARCH DEPARTMENT.

SOME few years ago the after-dinner speaker who had to reply for "Industry and Commerce," or some such combination, made it a practice to introduce the word "efficiency" as the text of his effusion. It was in no way necessary that he should know exactly what he meant by efficiency, or indeed that he should mean anything. It was a satisfying term which by its mere aura was going to solve all the problems of British trade. This delectable service and office has now been assumed by the word "research," and any distinguished publicist or writer in a daily news sheet appears to consider he has contributed to the advance of industry by commending it in general terms. This spurious popularity of "research" is somewhat unfortunate, and no ultimate good can come to the serious and valuable work to which the word really belongs by this turning of it to a catch-phrase. The public ultimately tires of parrot cries, and the final result is likely to be that an important subject will not be able to command the attention which it deserves.

Any effect of this kind which may follow the cheapening of "research" will be especially unfortunate, since although the average non-technical user of the expression may be quite incapable of contributing to the real problems of research, there is none the less some basis for his enthusiasm and he is reacting to a genuine impulse. There is no doubt but that many manufacturers in this country have been, and are still, too slow in attempting to develop new machines and processes and to apply commercially the possibilities which are put in their way by our investigators and inventors. Some valuable remarks on this subject were made in the recent paper read by Mr. W. Wilson before the Institution of Electrical Engineers. Mr. Wilson pointed out that "quite a considerable proportion of the apparatus actually manufactured in this country during recent years has been made to designs supplied from abroad," and that "in the Colonial and foreign fields the effect of this loss of initiative is especially evident, for prestige is there an important factor in determining success, and orders tend to be given to the actual authors of improvements and innovations." As Mr. Wilson pointed out there is no falling away in the originating power of our technical workers. Their war record is sufficient evidence of this. Our failure in initiative is a commercial failure, not a technical one. It is probable that much of the loose talk about research may be due to a general feeling that all is not well in this matter, and although it has an undesirable aspect, it may do useful work in helping to break down an evil custom.

Research in the mind, or at any rate in the speech, of the *cognoscenti*, is divided into pure and applied. The controversy about the relative fields of these is a barren one, but a very definite distinction has been epigrammatically suggested to the effect that an applied research worker knows what he is seeking for, and a pure research worker does not. If we are to adopt this distinction, we are here decidedly concerned with applied research which is being fathered to such an important extent by the Scientific and Industrial Research department, and under the ægis of which such useful work is being done by the various research associations. We have recently dealt so fully with the work of this Department that we need say no more here. Our present purpose is to examine the very evident tendency which is current to push the claims of research beyond their accepted sphere and to encroach on the arena of other recognised departments of industry.

Mr. Wilson's paper, to which we have referred, was entitled "Industrial Research, with Special Reference to Electrical Engineering Development," and was concerned with describing a department which apparently lay between the research department as ordinarily understood, and the drawing and designs department of a works. This research or development department was described as having its own workshop in which the first examples of new machines or pieces of apparatus could be built in order that in the factory proper "the absorption of time and disarrangement of routine that may be caused by the sandwiching of trial jobs between the regular items of work" might be avoided. This is very reasonable, but is not very new. The only thing which Mr. Wilson appears to have done, as far as the workshop side of the matter is concerned, is to change the name of the experimental department or the experimental shop into the development department. There can be no objection to this if the new name is preferred, but for the good fame of British industry it must be remembered that there were many experimental shops in operation before the modern worship of research was born.

There is a further aspect of the workshop side of this matter which may be referred to. There is a tendency—which we do not suggest that Mr. Wilson would support—when discussing this question to talk as if every engineering factory were engaged in the production of some one type of article on repetition lines. We admit that if one suddenly decided to build a 3-ton cargo winch in the middle of a factory engaged in making ball-bearings, it would be rather a nuisance and would throw matters out of gear, but most engineering factories are not making ball-bearings or any other uniform article, and in by far the majority of works there is no difficulty in arranging that the building of a new model or of a new type of article shall fall into the ordinary shop routine. We do not suggest that experimental shops are not frequently necessary or valuable, but to talk as if they were an essential feature of all factories is to throw the whole subject out of focus and to breed suspicion of their necessity in any case.

A more vital matter than the necessity or otherwise of an experimental shop is, however, contained in Mr. Wilson's scheme for a development department. It will clear ideas in reference to the matter if it is remembered that research is not invention. Research, if it is fortunate, may lead to discovery and incidentally also to invention, but invention is not its business. A research department is concerned in the main with the properties of materials. Invention comes in in the utilisation of those properties in commercial articles, and this utilisation is the

business of the designs department and the drawing office. In using the word invention we do not necessarily refer to important inventions which may be patentable and may lead to important advances. Invention in our present sense lies in the re-arrangement or the re-forming of parts—which is, after all, what most patented inventions consist of—and this re-arrangement and re-forming is the business of the design and drawing offices. Every good draughtsman is continually making small inventions.

This function of the design and drawing offices will, we imagine, be taken generally as a matter of course, but under Mr. Wilson's scheme this work is to be transferred to the development department. There is no question here of a mere dispute about names. It might be supposed that Mr. Wilson proposed that the development department should take over the work of these other departments and should, in fact, incorporate them. He, however, has no such idea. These departments are still to exist and while they are not apparently to be under the development department and subject to its orders, yet all their essential work is to be taken from them and done by it. A quotation will be useful here. Mr. Wilson says: "It may be stated definitely and emphatically that if the (development) department is to be efficient in its functions it must know the whole truth with regard to the design and performance of all the products for which it is responsible." The development department is to be "either the point of origin or the clearing house for new products . . . it must be the repository for all technical data concerned in the design of the articles made in the factory."

This really seems to be an impossible position. The development department is apparently to be the main and final designing department, and yet it is in some way to work in parallel with another ordinary sort of designing department, the duties of which are not clear. This is unworkable. Either the development department is responsible for design or it is not. If it is—and Mr. Wilson claims that it shall be—then there is no room for any other designing department. As the scheme stands, the department which is the repository of all technical information and—very naturally—"must know the whole truth with regard to the design of all the products for which it is responsible," is yet apparently to sit as a judge if anything goes wrong and blame the failure of any piece of apparatus, for which it itself "is responsible," on someone else. "When a complaint is received from a customer the development department will act as an adjudicator for the firm, examining the apparatus in question and the conditions under which it failed, bestowing the blame in the right quarter amd proposing a remedy."

The only way in which Mr. Wilson's scheme could be made to work would be for the development department to be part and parcel of the ordinary designs department and drawing office and under the same head. Possibly this is what he intends, and if so, it is interesting to consider Mr. Wilson's idea of a chief and staff for that department. We would suggest that there are comparatively few men in any firm who are capable of adding any important advance in the design of, say, rotary converters, and the same thing applies to most of the appliances of electrical engineering; and without elaborating the point it will be generally admitted that the head of a designs department must be one of the best men in a firm, of long experience, good training and personality. Above all, he must know a very great deal about shop conditions and manufacturing problems. The head of such a department in an electrical firm such as that with which Mr. Wilson was dealing would be quite an exceptional man. Mr. Wilson's main qualification for him, however, seems to be that he shall have a university training. He allows him some works experience, after graduation, and thinks it would be as well if he had inspected a number of works. This is the man who is to be "responsible"—Mr. Wilson's word—for the whole of the design in a large electrical engineering works dealing apparently with a great range of products.

We have been accused of attacking the B.Sc. degree. We admit no such charge, but anyone who wishes to make such an attack will find plenty of ammunition in Mr. Wilson's paper. It exhibits all the features which have led to the feeling of distrust of college-trained men which undoubtedly exists among many of the men who are really running engineering factories and doing practical engineering work. Mr. Wilson is his own best expositor. Talking about one of his development department university men browsing round a shell shop and giving kindly help to shop people in difficulties, he says: "Even one man with, say, a university degree in engineering and an enthusiasm for the work, would be able to reduce greatly the amount of scrap and to cause things to go more smoothly. He would be consulted if a gauge gave unsatisfactory results, and would be required to discover the reason and to correct the methods of gauging employed. Jigs that were misdirecting their drills for some obscure reason would be put under his observation." There is lots more of this kind of thing. It seems that "limit-gauging is a definite and intricate branch of physical science, and proficiency in it demands a knowledge of geometry, trigonometry, applied mechanics and the properties of materials."

Mr. Wilson's development department with the staff of university men of this calibre who understand the trigonometry of limit-gauging would certainly be a valuable factor in any works, even if we are unable to agree that they could run the whole of the designing, but it appears that such a staff can only be collected and kept with care. They must have a workshop equipped only with the best of machine tools and everything else, and their quarters must be carefully chosen in the factory. "The principal requirement as to site is absence of noise, especially spasmodic noise such as is caused by the tipping of castings. If this were to happen within close earshot of a man engaged in concentrated thought upon some intricate problem, the consequences would be not only to break the thread of his thoughts completely, but to administer a shock to his nervous system which, upon reiteration, would produce serious consequences." We are perhaps too much out of touch with works practice to be very familiar with the operation known as "tipping castings," but are prepared to admit that we are not fond of people shooting bricks alongside our own office, and have no wish to live next door to a hot-saw. In neither case, however, would we anticipate the serious consequences which it appears would accrue to Mr. Wilson's university men, and we would suggest to him that delicate temperaments of the kind described are out of place in an engineering factory. We would recommend a more restful business. Some of these men might profitably go into the bespoke tailoring trade. They might find their knowledge of trigonometry useful.

COAL ANALYSIS.

An unfortunate circumstance connected with coal analyses is that they have been made without standard methods, and the procedure of different analysts has thus varied in particulars that may have affected the results. It has accordingly been found that the results are not always comparable, and indeed that a comparison may be misleading unless the variations in method are known and duly allowed for. The Fuel Research Board in conjunction with local committees is engaged on a survey and classification of coal seams in various mining districts from the chemical and physical standpoints, with the object of providing data on which available coal could be used most economically; and in order to avoid uncertainties arising from the use of varying methods of sampling and analysis they appointed a committee on the subject, and have now published its first interim report.* This report deals with methods of analysis, which the Board has adopted for its own purposes, and hopes to see used by analysts generally, so that future results may be compared with certainty. The committee, which has still the important question of sampling under examination, will remain a standing committee of the Board, and will renew the publication periodically, after having submitted any fresh suggestions to experiment, hoping in this way to provide a trustworthy statement of the best current practice in methods of valuing coal. Many of the methods are identical with those published by the Joint Committee of the American Chemical Society and the American Society for Testing Materials, which they have varied only when the need of modification was shown experimentally. A full report at a later stage will include an account of the actual experiments that have led to the present recommendations.

The details of each analytical operation, given definitely in the report, are of interest mainly to analysts, and need not be described here. Broadly they are divided under the heads of proximate and ultimate analysis, the determination of phosphorus in the ash of metallurgical coke, the determination of the caking index and calorific value of coal, its laboratory assay at low and higher temperatures, and the method of reporting results. Some observations, however, made in the course of the report affect the interpretation to be placed on the results, and have therefore a more general interest.

The percentage of inorganic matter present in coal is usually taken as measured by the ash. Strictly speaking, however, the expulsion of water from kaolin and calcium sulphate and of carbon dioxide from carbonates and the conversion of iron pyrites into ferric oxide during ignition, all of which processes may occur in a proximate analysis, are changes of which each involves a loss of weight, which is not shown in the determination of the ash. A more accurate result would involve the quantitative analysis of the ash, but ordinarily and for most commercial purposes the uncorrected ash determination gives a sufficiently accurate measure of the inorganic substances. Similarly, in the ultimate analysis the amount of carbon present as carbonate appears in a single total with the organic carbon of the coal, and the hydrogen in the water of constitution not driven off from the organic and other constituents in the preliminary drying at 105 deg. C. to 110 deg. C., goes to increase the hydrogen figure of the analysis. The amount of carbon as carbonate can be determined accurately and deducted from the total carbon, but there is no trustworthy method for determining the amount of water of constitution, though an approximate correction can be made if the quantitative composition of the ash is known. It must be remembered, however, that the corrections for carbon in carbonates and hydrogen in water of constitution must not be made in a coal intended for use in boiler tests, or presumably in other furnace work, as in such circumstances both the carbon dioxide and the water will be reduced by the carbon and duly burned.

It is pointed out that there is no satisfactory direct method for determining oxygen in coal, and in an ultimate analysis the figure purporting to be oxygen is really a difference, which includes the total experimental errors of all the other determinations. It is intended therefore that in future the figure should be reported as "difference (oxygen and errors)."

The coking index is an empirical figure representing in some way the mechanical strength or coherence of the coal after it has been carbonised, and its value depends essentially on the details of the operation by which it is performed. In the method recommended by the report it is taken as the maximum ratio of sand to finely powdered coal, in a mixture prepared and carbonised according to the details given, that after carbonisation can bear a 500-gramme weight, the amount of loose powder being less than 5 per cent. This index can, of course, not be compared with index figures obtained on similar but not identical lines; but results obtained by the method described in the report obtained in the course of an enquiry instituted during the war into the coking coal seams of Scotland, are said to have shown a surprisingly close agreement between the coking index as determined in the laboratory and the practical estimate of the value of the coke produced by heating the ground coal in cotton bags in the coke oven. The extent to which a coal cakes on carbonising has a well-recognised practical significance for many purposes, and a trustworthy index will be of practical value. Investigations are proceeding into alternative methods.

* Physical and Chemical Survey of the National Coal Resources No. 2 Interim Report on Methods of Analysis of Coal. H.M. Stationery Office, 1s. 6d. net.

A detailed description is given of the method of determining the calorific value, which is done in an apparatus of the bomb type. It is pointed out, however, that even when using a thermometer reading to 0·001 deg. C. and calibrated by systematic observations of separated thread lengths, a closer agreement than 30 B.Th.U. between separate readings must be regarded as accidental, and results of 10,000 B.Th.U. and upwards are therefore meaningless in the fifth figure and uncertain within two or three units in the third.

For the low-temperature assay the Gray-King apparatus is used (*cf.* ENGINEERING, p. 169 *ante*), and for higher or high temperatures the Lessing apparatus, which can be worked at 600 deg. C. or 900 deg. C., or with platinum resistance wire up to 1,300 deg. C. As we pointed out recently (see p. 213 *ante*), the results of the Gray-King laboratory assays, like those here stated of the Lessing method, stand in some relation to the results obtained in carbonising on a large scale, but may require considerable corrections before they can be regarded as indexes of the behaviour of the coal in bulk. They are said, however, to give results closely comparable among themselves, and can be used with considerable advantage for sorting out and classifying coals according to the behaviour of samples on being carbonised in the assay apparatus. It seems probable that, when more has been done to solve the difficult problem of sampling, the results of these assay methods may have an important practical use, and supplement with advantage the indirect and inferential information to be obtained from analyses.

A useful suggestion is that proximate and ultimate analyses should be calculated not only on dry coal, but on dry ash-free coal, the moisture in the coal as received being returned separately so as to enable the figures of "coal as received" to be calculated when desired.

ATOMIC VOLUMES AND HARDNESS OF COPPER SOLID SOLUTIONS.

ALLOYS, solid solutions of metals in metals and solutions of solids in solids generally, are receiving increasing attention because, apart from their technical importance, they enable us to study the effects of small additions of one body to another, also as to mechanical properties. To obtain quantitative results, we must experiment with atomic proportions, and a large part of Roberts-Austen's alloys researches was undertaken in order to establish a relationship between the atomic volumes of the added elements and their influences upon the mechanical properties. The introduction of a foreign body into another solid must disturb the structure to an extent which, in some way, will be connected with the atomic volumes of the two elements, the solute and solvent. We do not understand how the addition of half a per cent. of magnesium to aluminium and its alloys causes the new alloy gradually to harden into duralumin. But such hardening effects are not rare. Mr. A. L. Norbury, M.Sc., of Swansea, communicated a paper upon the hardness of certain copper-alpha solid solutions to the Institute of Metals last spring; the paper was mentioned on page 323 of our issue of March 16. Last Monday he brought another paper on "Volumes Occupied by the Solute Atoms in Certain Metallic Solid Solutions and their Consequent Hardening Effects" before the Faraday Society. This latter paper dealt with the same copper alloys. The copper-alpha solution is the ordinary phase of copper; it exists throughout the whole temperature range 0 deg. C. to 1,000 deg. in copper-zinc alloys containing up to 37 per cent. of zinc; in other alloys its extent is more limited.

In order to refer properties to atomic volumes we must first know the density of the specimen and the changes of density which thermal and mechanical treatment will produce. Mr. Norbury determines the density on specimens of about 50 grammes weight, finished off with a fine file; the specimens are weighed in air and water while suspended by a platinum wire; in order to counterbalance the effect of the surface tension between the wire and water, a compensating wire of the same weight and length is attached to the other arm of the balance, the water in the two vessels being levelled by means of a syphon. The specimens were three commercial coppers and further electrolytic (cathode) copper fused under molten barium chloride to prevent oxidation; all were cold-hammered to reduce the thickness by 40 per cent. and 95 per cent. and then annealed at temperatures ranging from 400 deg. C. up to 900 deg. C. The progressive annealing decreased the density, from 8·924 to 8·853, probably because the gases in the minute blow holes (invisible at 100 magnification) expanded; cold hammering restored the greater density; after the thickness had been reduced to one-half, the density remained fairly constant at about 8·924. These figures refer to the cathode copper; the commercial coppers, annealed at 900 deg. and hammered down to 60 per cent. reduction in thickness, had a smaller density of about 8·905. In both cases the hammering was assumed to have closed up any blow holes.

The same annealing, fusion under barium chloride and hammering (to 60 per cent. reduction) was adopted in the case of the alloys with aluminium Al, silicon Si, manganese Mn, nickel Ni, zinc Zn, silver Ag, tin Sn. The densities of the alloys differed of course, but in some cases (Al, Si, Zn) the hammering had little influence on the density, indicating that the added elements eliminated the occluded gas, which was largely oxygen, probably. From the mean molecular weight and the densities found the mean atomic volumes were calculated. If the two metals of atomic weights A and B be present in percentages a and b, then the mean molecular weight of the alloy will be $Aa + Bb/100$, and the mean atomic volume will be mean atomic weight/density. Plotting now the mean atomic volumes against the atomic compositions, Mr. Norbury finds that the curves which are smooth but not straight lines, are strikingly similar (with the exception of Si and also Ni) to the Brinell hardness curves he had previously obtained. The alloys are harder than the copper; when the difference between the hardness of the one atomic per cent. solid solution and that of copper is plotted against the difference of the corresponding mean atomic volumes (alloy and copper), a straight line curve is obtained.

Mr. Norbury has been able to trace similar regularities by calculating the atomic volumes from the data compiled by Carpenter and Edwards, and by Rosenhain and Archbutt in the eighth and tenth Alloys Research Reports. There is further the strong support of Goebel's extensive researches on lead solid solutions (published in the *Zeitschrift für Metallkunde*, September to December, 1922). Goebel studied alloys of lead with bismuth, antimony, arsenic, tin, mercury, zinc, cadmium, magnesium and sodium, and he found the same parallelity between increasing atomic volumes and increasing hardness, again with one exception, the sodium alloy in this case. Of Goebel's lead alloys those with bismuth and sodium were, within limits, made more dense by increasing addition of Bi or Na (by 3·5 per cent. maximum) while all the other alloys were less dense (that with bismuth by 8 per cent.); but all the alloys were harder than the lead, the bismuth alloys to the smallest extent.

As regards the explanation of the hardening effect, Zay Jeffries and R. S. Archer suggested last year that the increased hardness was due to increased interatomic forces and to interference with slip, while Rosenhain proposed a few years ago that the hardening effect should, to a first approximation, be inversely proportional to the solid solubility of the solute, because the amount of distortion which the introduction of dissolved atoms produced in the space lattice of a solvent metal should govern both the limiting solubility and the degree of hardening. Mr. Norbury does not regard either of these explanations as sufficient. He would distinguish between atomic solutions (the ordinary case) and molecular solutions (the exceptional cases of silicon and sodium). In the former case, he suggests, atoms of the solute would replace atoms of the solvent and distort the space lattice according as they differed in size, the greater distortion causing greater hardening. But the copper lattice could apparently undergo a certain degree of distortion before the hardening set in; the hardness then increasing linearly to a maximum and falling off again. The exceptional cases were those of elements of low atomic weights, probably also of strong chemical affinity; they formed molecular solutions of intermetallic compounds having new space-lattices.

One does not quite see why these compounds should have greater hardening effects than the atomic solutions. Nor do we know much about the chemical affinities of these metals to one another. Manganese has a relatively strong hardening effect on copper, though it forms a continuous series of solid solutions, and other factors, Mr. Norbury said, might come in. There are, for instance, the uncertain contractions or expansions accompanying the formation of the solid solutions. In most of Mr. Norbury's experiments the normal atomic volume of the solute (by itself) was larger than the apparent atomic of the same in the solution, the comparative figures being, *e.g.*, for tin, 16·5 and 12·8; there was therefore contraction, but manganese expanded in the alloy (the figures being 7·6 and 8·9). These estimates are uncertain, however; by itself zinc, *e.g.*, has a hexagonal space-lattice; in the copper alloy it has to fit into the face-centred cube of copper, and we do not know how that takes place. Nickel which, as we stated, behaves somewhat exceptionally, is distinguished from the other elements in question by having a smaller atomic volume than copper. X-ray examination promises here, as in other structure problems, to be of great assistance. E. C. Bain found quite recently by these means that the lattices of copper-zinc and copper-tin alloys were less stretched than atomic volume studies indicated. Such X-ray studies have to be controlled by other experiments, and Mr. Norbury's experimental data and tables will be found very useful.

THE PHYSICIST IN THE TEXTILE INDUSTRIES.

RETROSPECTS of the advances of applied science have, during the past few years, been commanding the increasing appreciation of scientific research in the textile industries. Yet it may also be said, and the statement was made by Dr. A. E. Oxley when addressing the Institute of Physics on "The Physicist in the Textile Industries" at a recent meeting, that these industries are not using to the full the powers bestowed on this generation by scientific discovery. Dr. Oxley thought he could count the number of physicists at present engaged in England in textile research on his fingers, perhaps with a little assistance from the toes, whilst a brigade of trained physicists would be more in proportion to the urgent problems requiring attention. This may be granted without the slightest disparagement to the great services rendered by the trained operator, for the skill, based upon twenty, and sometimes fifty, years of mill experience can never be obtained by a man whose younger years have been spent in study as a scientist.

In opening his discourse, Dr. Oxley stated that the building-up of the textile industries has been one of the greatest factors in civilisation. As home arts, spinning and weaving were indeed great factors of civilisation already in ages that knew no industries, and they remain so up to the present in countries that are still permitted to live without factories. As large technical industries textiles have developed amazingly during the last two centuries. Yet the most important machine of spinning mills, the carding machine remains, in the words of a practical spinner, whom Dr. Oxley quoted at some length, "indispensable, but a failure. Careful carding does not eliminate the motes and neps, but keeps them within reasonable bounds. The speeds of the fundamentals of the carding machine, cylinder, doffer, flats, taker-in, have been varied indefinitely; the kind of wire, the counts, settings, the manner of grinding, have all been subject to experiment. Carding engines have been worked with movable and stationary flats, with roller and clearers, with combinations of these, forward and backward, and even without flats or rollers. As material for card wire, iron, mild steel and tempered steel, with chisel-ground, round points, plough ground and other points have been tried. Can the physicist help by systematic research?" We have shortened the

quotation. Dr. Oxley had no difficulty in showing that the physicist can help.

Perhaps he insisted a little too much on the disturbing variability of textile materials—cotton, wool, flax, silk—and the difficulties of sampling his test specimens. Books have been written and will be written upon the difficulties of finding representative samples of coal, ores, and chemical raw materials. But organic growth is more apt to vary than are artificial products, and the textile physicist certainly has a hard task and an almost unexplored field of research. All cotton fibres—Dr. Oxley spoke mainly of cotton, though the various machines he described are used in the textile industries generally—are twisted tubes; the fibre of Egyptian cotton is roundish in section, that of Indian cotton curved like a bean and more massive. The rigidity of the fibre can be exactly measured, in spite of its minuteness, with the aid of torsion pendulums; the mean couple for one twist per centimetre was found to vary from 0·01 dyne per square centimetre in the finest Sea-Island cotton to 0·111 dyne in the coarsest Indian fibre. That variation is very evident in the appearance and feel of the yarn, and it necessitates an empirical adjustment of twist in the spinning processes.

There is also, Dr. Oxley explained, a marked correlation between the rigidity and the length of the fibre—about 1 in. in Indian cotton, but varying much in the same boll and more still in cottons of different origins. The modulus of rigidity, calculated from observations on fibres approximating to circular rods, was found to be $0{\cdot}23 \times 10^{11}$ dynes per square centimetre, about 1/30 of that of steel; from that figure and the cross-section the degree of secondary thickening and of wall collapse can be estimated. The elastic properties of the fibres under stress of some duration are technically very important; to compare elastic imperfection, the decrease of a couple with time under constant twist was observed by the deflection of a small magnet suspended in a controllable field. The constants of the formula arrived at well expressed qualities of the materials otherwise vaguely described as springiness, limpness, feel, sagging, &c., and the effects of particular treatments and of humidity conditions could be studied in this way.

As the cotton passes through the various machines, some threads will be broken. Various methods are used to determine the extent to which this occurs, and other characteristics. In one method described the sample of cotton was drawn through a series of wire combs which laid the small tufts side by side on a plate covered with plush. The variability in fibre length then became distinct and, when the fibres were sorted to length-intervals of $\frac{1}{8}$ in. or $\frac{1}{16}$ in., and their weights on a micro-balance were plotted as a frequency diagram, predominant fibre-lengths could be ascertained, which was of great value, though the process was laborious. To test the evenness or regularity of the thread, which was very essential especially for fine fabrics, the thread was drawn between a pair of case-hardened steel shoes; the lower shoe was fixed, the upper shoe was riding on the thread which would raise the shoe more or less according to the degree of its own compressibility and twist, the more highly-twisted material being less compressible. A pointer attached to the upper shoe and a mirror system marked the up-and-down motion of the shoe as a right-and-left oscillation on a tape of bromide paper which was drawn downward at a rate proportional to the rate of the thread movement.

When this test was applied to a thread spun on a mule, the magnification of the diagram being 2,234 times in the horizontal and nearly 18,000 times in the vertical direction, evidence of a periodicity in the thread twist was obtained, and this could be traced to the intermittent action of the mule. In the woven fabric, plain or dyed, that periodicity would afterwards indicate its existence as a streakiness. Considering that there were 40,000,000 mule spindles in England against a total of 57,000,000 in the whole world, any slight improvement in the process due to these physical studies would fully justify itself. Threads spun on a ring-frame, which, as is well known, is the alternative to the mule, showed only non-periodic variations of twist hardness, this result being in keeping with the continuous nature of the ring-spinning process.

Breakages also occur in the loom in which the thread is submitted to oscillating tensions. In order to determine the effects of these stresses the threads are mounted in grips and subjected to a variable load, which changes with the static load and the speed and amplitude of the rotating cranks fixed at the top of the machine frame; loss of twist is prevented by the bifilar suspension of the load. This machine shows that, though the maximum load on the thread never attains the ordinary breaking strength of the specimen, yet all the specimens can be broken by a sufficient number of oscillations. Dr. Oxley ascribed the breaking to the minute accumulative permanent sets which occur for each oscillation, the fibres slipping slightly each time the load passes through a maximum. Some of the specimens break under a few oscillations, whilst those of high twist fortunately bear 5,000 oscillations, more than they may be expected to have to stand in weaving.

Other diagrams exhibited by Dr. Oxley showed that the stretching of the fibres under oscillating stress is rapid at first and again, finally, just before rupture. Though these phenomena were similar to the elastic fatigue of metals, Dr. Oxley emphasised as points of difference the variability of the textile material, which necessitated a very large number of tests to get a value representative of the bulk, and that the textile specimen could never be reproduced. Questioned as to these differences by Dr. E. H. Rayner, when proposing the vote of thanks to the lecturer, Dr. Oxley pointed out that the textile thread always consisted of many fibres more or less interlocked by twisting, and that at one application of stress the fibres might be able to glide through one another easily, whilst the next stretching might lead to further interlocking.

The lustre cotton goods, to which fancy and the trade now pay so much attention, is itself, of course, a physical property. But Dr. Oxley would regard the mercerisation of cotton—treating it with caustic alkali—rather as a physical than a chemical process, at any rate in the case of doubled yarns. A doubled yarn usually consists of two single yarns twisted together in the opposite direction to the twist put into the singles when they were spun. By means of a special photometer designed to measure the reflecting power of yarns it has been proved that the lustre of doubled yarns depends upon the final position of the original yarns, with respect to the axis. That position is a function both of the doubling twist and of the single-yarn twists, and Dr. Oxley's slides showed that a maximum lustre is secured by a certain relation between the two twists; as the doubling twist is increased, the lustre attains its maximum and then falls off again. Experiments with a modification of the above-mentioned machine for testing the regularity of the single yarns confirm this conclusion; when the lower shoe of that machine is replaced by a fine wire, each sharp peak on the photograph implies a half-doubling twist, and the percentage variation of the lustre is thus a measure of the regularity of the yarn.

In the other process for imparting lustre to textile fabrics—the Schreiner process—the physical nature is evident. The fabric is raised to a suitable temperature and humidity and is then passed between heavy rollers which are engraved with lines, 150 to 300 to the inch; the schreinered surface is therefore ruled somewhat like a diffraction grating.

Dr. Oxley, we need hardly say, has himself had a prominent share in the designs of some of the machines we mentioned. He is connected with the Shirley Institute for Textile Research, of Didsbury, Manchester, upon whose excellent work we have several times commented. In his concluding words, Dr. Oxley referred to the publication of their research work. Much of that work was more or less of a secret character; a great deal, at least on a par with the results of other scientific investigation, was published, but did not find sufficient recognition in the journals of scientific abstracts. If so, the textile associations may probably have to bear part of the responsibility. The vital importance of the textile industries is certainly not underrated in this country. The discourse, we should add, was the fifth of the series of lectures on "Physics in Industry," given in the Institute of Physics; the president of the Institute, Sir Charles Parsons, was in the chair.

NOTES.

International Regulations in Connection with Communications and Transit.

The League of Nations has under consideration the question of the regulation of matters affecting international communication by rail and sea, &c. A general conference on the subject was held in Barcelona in March, 1921, but as sufficient preliminary work had not been accomplished the matter was adjourned for future consideration. The conference appointed an Advisory Technical Committee which has been at work since, and as a result of the studies made a series of four conventions has been drawn up for consideration at a general conference at Genoa which met yesterday. The convention relating to railway communication is said to be the most important. The proposals are embodied in a convention and a statute, the latter detailing the principles recommended. These are intended to facilitate intercommunication by means of junctions between lines at frontiers, in order to facilitate through working; the provision of common frontier stations; the protection and equality of treatment of traffic without political prejudice; the provision of through trains or carriages; simplification of customs, and various other points connected with speed, safety and comfort, of a more technical nature. The statute further covers the uniformity and exchange of stock, tariffs and other matters, all of which are drawn up in what appears to be a reasonable and desirable manner, and are mainly aimed at preventing discrimination and the provision of fair facilities. The convention on maritime ports is similarly prepared to prevent discrimination against nations or particular forms of traffic. The third convention deals with the transit of electric power, while the fourth is concerned with the exploitation of water resources in which two or more countries are interested. These latter are not of the detailed character of the two former, as it is considered that the time has not come for dealing with them in the same way. It is proposed that the former two conventions should come into force when ratified by five Powers and the latter two when ratified by three.

The British Empire Exhibition.

An important stage in the constructional work of the great exhibition which is to be held at Wembley next year was reached last Monday, when the Palace of Engineering and the Palace of Industry were handed over by the contractors to the exhibition authorities. These two buildings, which are of approximately equal size, the engineering building being slightly the larger of the two, cover a total area of 23 acres. The excavations for the Palace of Engineering were begun in August, 1922, and for the Palace of Industry in June, 1922, and a very remarkable piece of work has been accomplished by the contractors, Messrs. Sir Robert McAlpine and Son, in erecting two such structures in well under eighteen months. They originally undertook to be ready with the buildings on November 11, and the close adherence to schedule which has been achieved forms, one may hope, an indication that the whole exhibition will be properly completed by the opening day. The exhibition will include a very large number of other buildings devoted to the special displays of the various countries of the Empire. These are, in general, well forward, and Sir Travers Clarke, the deputy-chairman of the Exhibition Board, speaking at a luncheon held in connection with the handing over of the Palaces of Industry and Engineering, said that it was hoped to have all buildings practically completed this year. None of the other sections is so large as those devoted to engineering and industry, but many, such as those to contain the exhibits of Canada, Australia, India, &c., are very large structures. The Palace of Engineering is a permanent erection and is probably the largest concrete building in the world. It has a floor area of over half a million square feet, and the five bays are served by main-line gauge railways and overhead travelling cranes. In the construction of this and the industry building 12,000 tons of concrete and 1,200 tons of steel reinforcement have been used. Both buildings are

handsome and impressive structures internally and externally and reflect great credit on the consulting civil engineer, Mr. E. O. Williams, and the architects, Messrs. Simpson and Ayrton.

Petrol Electric Commercial Cars.

In a paper read before the Institution of Automobile Engineers on Wednesday evening last, Mr. L. Murphy advocated the adoption of the petrol-electric drive for heavy commercial cars and lorries. The petrol electric system is, of course, anything but new, and large numbers of such vehicles are in commercial use, so that actual operating costs are available, and the advantages and disadvantages of the system as compared with the use of the simple petrol engine are well known. Mr. Murphy stated that if a petrol engine were as efficient in service as it is in a bench test, a lorry weighing 8 tons fully laden should run 15·7 miles per gallon, and that a transportation efficiency of 125 to 142 ton-miles to the gallon should be realised. Actually, he stated, about 68 ton-miles to the gallon represented about the best figure achieved in practice. He proposed accordingly an arrangement in which the vehicle should be electrically driven by a motor supplied from storage batteries, supplemented by a petrol engine. This engine would be run at constant torque and through only a limited range of speeds, thus securing a high efficiency. The speed of the vehicle would be controlled entirely by varying the field of the motor. A range of from 4 to 20 m.p.h. would be provided for, but the controller would be fitted with "an economical half speed position" giving a minimum speed of 2 m.p.h. with the option of accelerating up to 10 m.p.h. Intermediate speeds of 1 and 3 m.p.h. would be provided for by resistance control. The battery required is estimated to weigh one-ninth the gross weight of the vehicle and its load. The engine would, however, only require, it was stated, to be of from 2,000 to 2,200 c.c. capacity as against the 7,000 c.c. capacity now fitted. Moreover, owing to the steadiness of the electric drive, certain parts could be made lighter than is admissible with the "straight" petrol car. Hence, it was stated, the total machinery weights would be less than what was now normal. On down gradients the motor would act as a dynamo and re-charge the batteries. The engine would be cut out when not required and Mr. Murphy claimed that in this way fuel costs for a lorry could be reduced to from 0·154*d.* to 0·294*d.* per ton-mile.

New Types of Service Aircraft.

In connection with the Imperial Conference recently held in London, the representatives of the various Dominions attending the Conference were invited by the Government to visit the London Terminal Aerodrome at Croydon on Saturday last, the 10th inst., to see some of the latest types of civil and military aircraft and also to witness the performance of the machines in the air. They were also able to inspect the general organisation of the aerodrome for carrying on the cross-Channel and other aerial transport services. As is well known, the Air Force, for reasons of economy, has hitherto been mainly equipped with machines produced during the war, but the re-equipment of the Force with new machines will now take place gradually in order to take advantage of improvements effected during the last few years. Several machines of recent design, which will be used for the purpose, were present at the aerodrome, and among them were some specially designed for co-operation with the Navy. Of these we may mention the Fairey "Flycatcher" and the Parnall "Plover," which are new ships' fighting aeroplanes designed for taking off from and alighting on the decks of aircraft carriers as well as land aerodromes. They are of small span and are fitted with 320 h.p. Siddeley Jaguar radial engines which enable them to attain a high speed with full military load at altitudes of 10,000 ft. and upwards. The facility with which these machines can be manœuvred in the air was strikingly demonstrated to the visitors. Among other types of modern naval aircraft represented were the Blackburn fleet spotter and the Blackburn "Dart" torpedo carrier, the latter being the machine with which the naval torpedo-carrying squadrons have recently been equipped. These machines, and another torpedo carrier, the Handley-Page "Hanley," are fitted with Napier Lion engines, and an interesting feature of the last-mentioned machine is that it has the now well-known form of slotted wing. Another naval machine shown was the Supermarine "Seagull," which is of the amphibian type and has been specially designed for naval reconnaissance duties. The aeroplanes for land service shown included new single-seater and two-seater fighters, long-distance reconnaissance machines, and bombers. Of the single-seater fighters we may mention the Siddeley "Siskin," a machine of all-metal construction, and the Gloucester "Grebe." Both these machines are fitted with Jaguar engines and have a very high speed. Among the new bombing machines was the Boulton and Paul twin-engined "Bourges," having particularly good manœuvring qualities which greatly increase its military value, and another machine by the same firm, known as the "Bugle" and fitted with two "Jupiter" radial engines. Other bombers which may be mentioned were two Avro "Aldershots," one fitted with the new 1,000 h.p. Napier "Cub" engine and the other having a 650 h.p. Rolls-Royce "Condor" engine. The Vickers "Virginia," which was also shown, is a bombing machine equipped with two Napier "Lion" engines and another of Messrs. Vickers products present was a day bomber known as the "Vixen." Finally, we may mention the Fairey "Faun," designed for long-distance reconnaissance work and fitted with the Napier "Lion" engine, and the "Springbok," which is intended for Army co-operation duties. The last-mentioned machine is manufactured by Messrs. Short Brothers and is of all-metal (Duralumin) construction, the power unit being a Bristol Jupiter air-cooled engine. It is not possible at present to publish particulars of the dimensions and performances of these new machines, but their introduction should do much to restore the Royal Air Force to that position of superiority with respect to *matériel* which it achieved during the last stages of the war.

LITERATURE.

Cotton Mill Management. A Practical Guide for Managers, Carders and Overlookers. By W. Scott Taggart, M.I.Mech.E. London: Macmillan and Co., Limited. [Price 10*s.* net.]

Mr. Scott Taggart is well known as the writer of books describing the methods of cotton spinning and of the machinery used throughout the industry. The many editions in which these works have appeared, testify both to their value and to the eagerness of those engaged to acquire that accurate information which will advance their own command of detail and improve the conditions of manufacture. No detailed counsel given in this book on the management and superintendence of machinery is of greater importance, than his insistance on the necessity of securing adequate, individual, training in the technical schools, and of the value of imbibing the collected experience of others. Such advice may be unpalatable and appear unnecessary to those who have seen trade prosper and admirable results produced, unaided by scientific direction. Those familiar with the riotous days of prosperity are indifferently tolerant of evening classes, but the ideal of a lad wasting two or three years of his life in attending day classes, is repugnant to those who want to see their children earning as soon as possible, and think it their duty to get them into the mill at an unreasonably early age, trusting their after career to evening classes and Providence. We regret to read of the dislike approaching abhorrence with which the operatives regard theory and theoretical instruction. "Theory," says the author with fine scorn, "must on no account be thought of, much less mentioned in connection with cotton spinning." Impressed by this conviction, the author, though writing for those who will guide and instruct others, rarely appeals to the mathematical knowledge of his readers, beyond the extent of working an arithmetical sum that would not tax the skill of a boy in the fifth form. His book, it will be understood therefore, is mainly descriptive. He foresees the difficulties that will arise in front of a machine and suggests the appropriate remedy, or indicates a method of working that will prevent the trouble arising.

Still, though cotton mills are notorious for the perpetuation of old-time conditions, there are signs of better times approaching. Competition is not an unmixed evil. It acts as a fine spur to awaken activity, and compels us to search out and remove our weak spots. It forces us out of old grooves, and compels the adoption of more enlightened methods, and in this connection, Mr. Taggart is able to refer with satisfaction to the earnest endeavours of those, who through technical schools and lectures are equipping men for the struggle, and enabling them to overcome the drawbacks of lost or absent opportunities of an earlier period in their career. Among these beneficient influences, we may place in the front rank the Shirley Institute for Cotton Industry Research, devoted to the development of accurate knowledge and the acquisition of mechanical skill, where those actively engaged in the industry have opportunity for obtaining a more intimate acquaintance with the processes involved than can be gained in other schools, remote from the seat of manufacture. The existence of such an institution is the more necessary, as deft manipulative skill, which in some individuals seems an instinct rather than an acquired dexterity, may lose its value by the introduction of more automatic machinery. Mr. Taggart, in discussing the relative merits of the Heilmann and Nasmyth types of comber machines, shows that a more modern invention may sweep away the advantages conferred by hardly-earned experience and render of little avail that delicate manipulation of the machinery that long years of constant application has made second nature. New conditions require a readjustment of memorised facts that have been utilised without thought or effort. Naturally such a revolution is not welcomed by the conservative members of the craft, and a spirit of opposition is raised that breeds friction and delays useful innovation. But younger men, scientifically trained, alive to the mechanical and economical advantages latent in a change of procedure, will welcome the novelty and demand its introduction.

This is the class addressed in this volume, which may be regarded as a sequel to the "Cotton Machinery Sketches" by the same author, to which the reader is referred for the illustrations that would have been of use here. We cannot think that this divorce is of any advantage, defended on the ground "that the reader is well acquainted with the various machines and their mechanical details." The plan of the book is to devote a chapter to the main operations carried on in the mill, to declare the objects that the use of a particular type of machine is intended to achieve, and to describe the processes of operation. Then follow a number of hints and notes having reference to the mechanical troubles likely to arise, showing how they may be remedied or prevented. Managers and supervisors will have had many examples of the troubles that carelessness, stupidity, or ignorance occasion, and have their own methods of reducing these to a minimum. Here, however, the word "manager" applies to all those who are ambitious of advancing their position, and feel capable of exercising control and direction. To those who are receptive by temperament, we conceive the book will be of use by its suggestions and information; others disregarding the good intentions of the author may resent his well-meant interference.

A Century of Locomotive Building by Robert Stephenson and Co. By J. G. H. Warren. Newcastle-upon-Tyne: Andrew Reid and Co., Ltd. [Price 28*s.* net.]

Stephenson! The name truly carries one back to the beginning of railways—no, not quite the beginning; to something even more important—the date when by the untiring work of two great men they were raised to the level of really practical means of transport. We are now rapidly approaching the centennial of the railway era. Shall we whisper it that one company has already kept its centenary, though the genuine anniversary will not be held for two years from now—when an international celebration will be held in this country—of the opening of the Stockton and Darlington Railway? Last April the Delaware and Hudson Company organised a little spectacle. We have no quarrel with the event, for it was honestly put

forward as the one hundredth anniversary of the company and not of the railroad; and the company commenced as a mining and canal concern, and only took up railroads in 1828, when, be it observed, their first locomotive—the first in America—was ordered from Stephenson's of Newcastle. By that date, the centenary of which it is hoped to celebrate in America in a characteristically spectacular manner, the firm of Stephensons were already established, even in the export trade, and foreign engineers had become thoroughly interested in their locomotives.

To the father and son, who were not only the leading locomotive engineers of the day, but civil engineers of great attainments, the world owes an undischargable debt. They are of the famous company of whom in Ecclesiasticus it is sung, that "These be of them that have left a name behind them, that their praise might be reported." The name is a household word in the land, and, if there were no other monument to its repute, would still be most effectively upheld by the great firm at Newcastle. "Their bodies are buried in peace"—the one at Chesterfield and the other in Westminster Abbey—"but their name liveth for ever." May it indeed be so, and may it survive as long in the firm they founded.

Setting aside all claims made for George Stephenson as the inventor of the locomotive—others, of course, had priority in this, and he followed Trevithick, Blenkinsop and Hedley—there is still plenty to his credit. His first engine was built in 1814, but the firm bearing his son's name was only founded in 1823, by which time, for those days, his experience had been considerable. It is the firm's centenary which is signalised by the appearance of this volume by Mr. Warren. As all would expect of a concern with such a beginning the record is a great one. Mr. Warren has handled his subject well. He has not indulged in controversy with the object of belittling the genius of other pioneers, and has waived claims for the Stephensons made by over-enthusiastic protagonists in the past. As to the early years, he has confined himself to the work, sometimes original, sometimes development merely, accomplished by two master hands and minds, and the story is a very interesting one. The company soon acquired what at the time was unique experience. George had been building practical "travelling engines" for nine years when the firm was launched, and the experience gained with these, at collieries, and with the early machines built for the Stockton and Darlington, soon put into the hands of the firm information from which valuable suggestions were derived. The result was that Stephenson designs were asked for if Stephenson-built engines could not be secured. The experience accumulated resulted in the Rocket, whose success at Rainhill finally ended the long-drawn-out controversy of the fixed *versus* the travelling engine, though under exceptional circumstances rope haulage on inclines survived till quite recently, as for instance, at Cowlairs. The Rocket gave us the prototype of the present form of fire-box and, with the Lancashire Witch, broke away from the vertical cylinder. The Northumbrian type, which soon followed, even more nearly approached what came to be recognised as essential lines of design.

To the Stephenson Planet, however, belonged the honour of being the first locomotive on modern lines. Though it only had four wheels, it will be found that when the design is considered, the modern engine in essentials is an enlargement of it, of necessity fitted with further wheels to distribute the load and provide adhesion commensurate with the power developed. The Planet, we believe, was the first engine in which the modern type of drive was adopted, from cylinders, horizontal or nearly so, at the front end, to a driving axle further to the rear. The cylinders were placed side by side under the smoke-box, thus originating one of the features for many years distinctive of British practice and opposed to practice abroad.

At this point we may leave Mr. Warren, for we cannot pretend to touch here upon all the progressive developments which he records, or the points which he has marshalled so effectively and on lines not previously attempted. From the early years he has brought his firm's record down to date. It is a record which reveals pioneer work in many directions of design, and in many countries. The author has had the benefit of access to, and the work is adorned by, a considerable amount of hitherto unpublished material which supplies links in the historical chain. Some of this is not conclusive evidence and Mr. Warren honestly confesses to the fact, for which his readers will be grateful to him. It is better to be honest in these things than to be carried away by enthusiasm or bias, for in the latter case some old record may at any time come to light to disprove the theory advanced, when the author stands before the world discredited, and the veracity of his whole work is jeopardised. With Mr. Warren we feel we are safe. He leaves the future to throw light on some of the things which are not capable of decision with our present sources of information. In some cases possibly we never shall know now the exact details of history; in others we may still have the good fortune to become enlightened. The book is worthy of the subject. The firm so worthy of its forebears, has done good work for the world, and we sincerely hope, for its own sake, and for the sake of its historic associations, that "its shadow may never grow less," and its future prove as distinguished as its past.

The Newcomen Society for the Study of the History of Engineering and Technology. Transactions, Vol. II. 1921–22. London: Published by the Society. [Price 20*s.*]

THE second volume of the Proceedings of the Newcomen Society, which has recently been published, affords good evidence of the value of the line of work which the society has taken in hand. Its contents include 10 papers contributed to the society's meetings and these are all of interest. The first, entitled "The Early History of Mechanical Handling Devices," is by Mr. G. F. Zimmer, and traces out briefly the development of early water-raising appliances and the introduction in some cases, at very early dates, of the predecessors of the various types of conveyors which in the present day are so largely used with excellent results. Next follows a lengthy paper by Mr. C. F. Dendy Marshall, on "The Liverpool and Manchester Railway," which gives a very complete history of the line and interesting particulars of the early locomotives used on it.

The third paper, which was contributed by Mr. R. C. Skyring Walters, deals with "Greek and Roman Engineering Instruments," while the fourth is entitled "Mechanics and Engineering from the Time of Aristotle to that of Archimedes," the author being Dr. T. East Lomes. This is followed by a paper on "Timothy Hackworth and the Locomotive," by Mr. Robert Young, which evolved a discussion and some correspondence of considerable interest.

The next communication is a lengthy one entitled "The Centenary of Naval Engineering," by Engineer Captain Edgar C. Smith, which contains much information arranged in a very convenient form concerning the development of the engineering branch of our Navy. Next follow "A Holograph Letter of Newcomen," communicated by Dr. Conrad Matschoss, and "A Note on Brunton's Steam Horse, 1813," by Mr. Loughnan St. L. Pendred, who illustrated his paper by the exhibition of a working model made by him of this remarkable, but certainly unsatisfactory, invention. The remaining papers dealt with are one entitled "Notes on Heaton's Steam Carriage of 1830," by Mr. Arthur Titley, and one on "Gurney's Railway Locomotives, 1830," by Mr. E. A. Forward, while the volume also includes an interesting note on "An Eighteenth Century Engineer's Sketch Book," by Mr. H. W. Dickinson, and an "Analytical Bibliography of the History of Engineering and Applied Science, 1900–1920."

The above brief enumeration of the contents of the volume under notice will, we think, show that the Newcomen Society well merits the support of engineers, and we trust that its meetings will be well attended, particularly by the older members of our profession who may be able to contribute interesting information, hitherto unpublished, based on the experience of their younger days. In conclusion, we wish to make a suggestion. It will certainly often happen that papers such as those we have enumerated can only be very imperfectly discussed at the time of their reading, whereas after they have been published in the Transactions they will come under the notice of many members and others who are able to contribute further facts of historical interest. It would, therefore, be a good thing if the society would encourage the receipt by the secretary at all times of correspondence bearing upon papers which have been read at its meetings. Such correspondence need not be reproduced in full, but the facts of interest contained in it might be summarised from time to time and printed as an appendix to the ordinary contents of the Transactions. Many hitherto unrecorded facts might thus be brought to light and the accuracy, or otherwise, of certain doubtful statements might be definitely settled.

BOOKS RECEIVED.

Successful Wireless Reception. By PAUL D. TYERS. London: Percival Marshall and Co. [Price 1*s.* 6*d.* net.]

Die Konstruktionsstähle und ihre Warmebehandlung. By Dr. Ing. RUDOLF SCHAFER. Berlin: Julius Springer. [Price 15*s.* 11*d.*]

The Rediscovery of Truth by the Solar and other Spectra. By EDWARD HALL, B.A. London: George Routledge and Sons, Limited. [Price 15*s.* net.]

Production, Condensation de la Vapeur. By E. SAUVAGE. Paris: J. B. Bailliere et fils. [Price 35 francs.]

Department of Overseas Trade.—Report on the Trade and Industry of Persia to June, 1923. By R. H. HADOW. London: His Majesty's Stationery Office. [Price 9*d.* net.]

Aeronautical Research Committee. Reports and Memoranda No. 602. *The Stability of Airships. General Case. The Mathematical Theory and its Application. With Appendix.* By J. L. NAYLER, B.A., and R. JONES, M.A. London: His Majesty's Stationery Office. [Price 1*s.* 4*d.* post free.]

The Book of the Ford. By R. T. NICHOLSON, M.A. Eighth edition, revised. London: The Temple Press, Limited. [Price 2*s.* 6*d.* net.]

The Electrical Contractors' Year Book, 1923–24. London: The Electrical Contractors' Association, Inc. [Price 2*s.* 6*d.*]

The Journal of the Iron and Steel Institute. Vol. CVII, 1923. Edited by GEORGE C. LLOYD. London: Offices of the Institute.

The Iron and Steel Institute. Carnegie Scholarship Memoirs. Vol. XII. Edited by GEORGE C. LLOYD. London: Offices of the Institute.

United States Department of Commerce. Lighthouse Service. The United States Lighthouse Service, 1923. Washington: Government Printing Office.

Amerikanische und deutsche Grossdampfkessel. By Dr. Ing. FRIEDRICH MÜNZINGEN. Berlin: Julius Springer. [Price 7*s.* 9*d.*]

The Institution of Railway Signal Engineers. Proceedings. Part I, 1923. Reading: Officer of the Institution. [Price 7*s.* 6*d.*]

Car Lighting by Electricity. By CHARLES W. T. STUART. New York and London: The Simmons-Boardman Publishing Company. [Price 4 dols.]

Air Ministry. Meteorological Office. Particulars of Meteorological Reports issued by Wireless Telegraphy in Great Britain and the Countries of Europe and North Africa. London: His Majesty's Stationery Office. [Price 2*s.* 6*d.* net.]

Der Torsionsindikator. By Dr. Ing. PAUL NETTMANN. Berlin: M. Krayn. [Price 5*s.*]

Early Science in Oxford. Parts III and IV. *Physics and Surveying.* By R. T. GUNTHER. Oxford: University Press. [Price 21*s.*]

Elasticity and Strength of Materials used in Engineering Construction. Section III. *Theory of Torsion in Shafting and Double Bending of Plates.* By C. A. P. TURNER. Minneapolis: C. A. P. Turner. [Price 5 dols.]

Motor Vehicles and Their Engines. A Practical Handbook. By EDWARD S. FRASER and RALPH B. JONES. Second edition. London: Crosby, Lockwood & Son [Price 10*s.* net.]

Englisch fur Techniker. Part II. *Elektrotechnik.* By Dipt-Ing. CARL VOLK. Berlin and Leipzig: Walter de Gruyter and Co. [Price 1*s.*]

English for Engineers. By S. A. HARBARGER. First edition. London: McGraw-Hill Publishing Co., Limited. [Price 10*s.* net.]

Foundry Work. A Text on Moulding, Dry-Sand Core-making, and the Melting and Mixing of Metals. By R. E. WENDT. First edition. London: McGraw-Hill Publishing Co., Limited. [Price 10*s.* net.]

THE LAW'S DELAYS.—The Federation of British Industries gives publicity to a complaint from a member company regarding the delays which they experienced in connection with litigation between themselves and the Inland Revenue Authorities. The taxation assessment against which the company appealed was dated October, 1919. Since that date, it has passed through the following stages: April, 1920, heard by Special Commissioners, London—judgment for the company; November, 1921, King's Bench Division—judgment for the company; April, 1922, Court of Appeal—judgment for the company; March, 1923, House of Lords—judgment reserved. Judgment was finally given in favour of the company at the end of June. Members also complain regarding the loss of time to directors and officials by attending the courts in London before a case is actually called.

THE EFFECT OF AGE UPON CIMENT FONDU.

In view of the interest which previous references in our columns to Ciment Fondu have aroused, the figures given in the appended table should prove of value. The point has many times been raised that, although this material may show up exceptionally well when tested new or shortly after moulding, sufficient time has not elapsed for it to be possible to say that it is stable and will retain its strength permanently.

The tests, of which the results are given below, were made under the supervision of M. le Gavrian, Chef du Service des Laboratoires de l'Ecole des Ponts et Chaussées, and were carried out at the Laboratoires d'essais Physiques-Mécaniques, Paris, having been reported upon last month. The figures given are reproduced from M. le Gavrian's report, which is covered by a certificate dated October 27. It will be noted that the figures substantiate the facts which we have previously stated with regard to the characteristics of the material, and, in addition, prove that there is no deterioration of strength, but a consistent increase, at least as far as the tests have gone (five years). It will be noted that the 1916 cement shows up best, as is perhaps natural, since considerable improvement is said to have been effected in manufacture since the earlier days of its introduction, and the present-day product is claimed to be still further superior to that of the earlier periods. The tests were made on 0·2 m. (7·87 in.) cubes.

Crushing Strength of Ciment Fondu at different Ages, in Kilogrammes per Square Centimetre (Figures in Brackets, Pounds per Square Inch).

Age when Tested.	Date of Moulding and Condition of Storage.			
	October, 1915.		March, 1916.	
	In Open Air.	Under Water.	In Open Air.	Under Water.
1 day ..	—	—	118 (1,673)	—
2 days ..	—	—	247 (3,520)	—
3 days ..	312 (4,444)	277 (3,945)	325 (4,622)	261 (3,700)
7 days ..	315 (4,480)	320 (4,551)	427 (6,080)	413 (5,880)
28 days ..	369 (5,260)	332 (4,727)	541 (7,685)	517 (7,360)
90 days ..	387 (5,510)	364 (5,180)	587 (8,365)	564 (8,020)
6 months ..	424 (6,040)	—	626 (8,900)	604 (8,600)
1 year ..	466 (6,631)	—	658 (9,353)	640 (9,103)
2 years ..	480 (6,827)	—	667 (9,493)	630 (8,960)
3 years ..	473 (6,730)	—	682 (9,707)	657 (9,350)

The cement received and used in October, 1915, was made up in the following proportions, 400 kg. of cement: 300 litres of Seine sand: 900 litres gravel. The water used was 8·7 per cent.

The cement received in 1916 was of a somewhat darker colour, and not quite so finely ground, producing a less rich mixture. The proportions were as above, except that 7·9 per cent. of water was used only.

We may add that Ciment Fondu is handled in this country by the Lafarge Aluminons Cement Company, Limited, Regent House, Kingsway, W.C. 2.

Allen-Liversidge, Limited.—Confidence in a future of increased activity in the acetylene industry and in the continuance of the excellent teamwork of the staff, were the characteristics of the speeches of Mr. C. Storey Gilman and other directors of the firm of Allen-Liversidge, Limited, at the annual dinner of the London staff, which was held at the Trocadero Restaurant on Friday last.

The New United States Battleship "Colorado."—At the end of September the new United States battleship Colorado was delivered to the navy. Her sister ship the West Virginia is due in December. The Americans claim that these vessels with the Maryland, which is at present in commission, constitute a squadron of the most powerful battleships afloat. Their details are: Load displacement, 32,600 tons; designed horse-power, 28,900 tons (turbines); designed speed, 21 knots; radius of action at economical speed, 14,400 miles; fuel capacity, 4,600 tons to 5,000 tons (oil); length, 624 ft.; beam, 97 ft.; draught, 30¼ ft.; armament, eight 16-in. guns, twelve 5-in. guns, eight 14-pounder guns (anti-aircraft), four 6-pounder guns, two 1-pounder guns, two 21-in. submerged torpedo tubes, two aeroplanes. It is not yet possible to compare these ships with our projected Nelson type; though it would seem that, when completed, ours will be slightly the more powerful. Their load displacement will be 35,000 tons; their length 710 ft., and their beam 106 ft.

THE TIDES FROM AN ENGINEER'S STANDPOINT.*

By Edward William Hollingworth, M.A., M.Inst.C.E.

The view suggested in the paper is that the idea of a tide-wave is misleading, and that it is simpler to think of the tides as being due to horizontal movements generated by the tide-raising forces in the deep water of the ocean. These movements are intensified in the shoal water round the coasts, and become the well-known tidal streams.

The rise of tide is due to obstruction of this motion, kinetic energy being converted into potential energy. The range of tide depends upon the degree to which the flow is opposed; where strong currents exist the rise is comparatively small. Where a particular component of the tidal motion meets no obstruction, it causes no rise; so that, if the coast runs north and south, there will be no diurnal inequality, while on a coast running east and west one-day tides will be found.

The ebb tide due to the reconversion of the potential energy into motion is independent of the tide-raising forces and depends on geographical conditions, the streams taking the directions which give the quickest escape to the banked-up water. In a deep gulf the ebb will be in the reverse direction to the flood, but on an open coast which the flood strikes obliquely the ebb will be more or less in the same direction, resulting in a littoral current. In consequence of the ebb being independent of the tide-raising forces, its total energy must be less than that of the flood by the energy lost in friction. The mean sea-level towards the end of a long inlet, in consequence, will be higher than at its mouth, and half-tide level will be higher at springs than at neaps; the ebb will also last longer than the flood.

In long gulfs an oscillation of the whole body of water is set up, and the rise of tide does not then follow each of the tidal impulses, but increases as long as the force is above the mean. This causes the "age of the tide."

The effect of storm waves on the material on a beach is to remove it into deeper water, where it becomes the sport of the currents until it is cast up again during off-shore winds. The total energy of the flood being greater than that of the ebb, the material will move, on the whole, in the direction of the flood tide.

The greatest movement takes place in water of moderate depth where the main stream is felt and the waves keep the material in motion. The result is seen in the formation of river bars and lagoons. If the main flood sets up an estuary, instead of across it, the material is deposited in banks lying up and down stream and eventually forms a delta. The tendency of the drifting material is to move towards the heads of all inlets, where large deposits are found; these are capable of reclamation if sufficient silt is supplied by adjacent rivers.

A survey of the present condition of ancient ports reveals the greatness of the changes which have taken place in the coast lines during a comparatively short period, and which can be traced to the influence of the flood tide.

THE EFFECT OF GROYNING ON SOME PARTS OF THE ENGLISH COAST.*

By Richard Fuge Grantham, M.Inst.C.E.

During 1922 much damage was done on the east, south and west coasts of the country. The object of the paper is to show the importance of, and in most cases the necessity for, groynes for the protection of the coast-line. The direction of the travel of littoral drift on each part of the coast is described, the movement on the east coast being from north to south, on the south coast from west to east, on the west coast to Morecambe Bay from south to north, and north of Morecambe Bay from north to south.

The case of the Scarborough sea-wall and bay, and the reports thereon of Dr. H. Lapworth and Professor Kendall, are referred to as showing the serious lowering of the level of the shore, owing, as the author suggests, to the absence of groynes in front of the sea-wall. The opinions of the late Mr. W. H. Wheeler and of the late Sir William Matthews on the danger of building sea-walls without corresponding protection of the shore below them are quoted.

The encroachment of the sea on the Yorkshire cliffs and the effect of building groynes in preventing the sea from breaking through Spurn Head into the River Humber about fifty years ago are described.

Reference is made to the large quantities of drift travelling along the Yorkshire and Lincolnshire coasts and to the variations in the movement; and the suggestion is made that the drift on the Lincolnshire coast may be derived from the *debris* of the cliffs on the Yorkshire coast.

A breach occurred in the sandhills at Ingoldmells Point on the Lincolnshire coast in 1919, and in order to restore the breach the author formed a clay embankment across it and erected groynes on the shore, which had the effect of collecting the drift and protecting the front slope of the embankment.

The remarkable shingle bank between Blakeney and Weybourne, its gradual advance and encroachment on the marshes behind it, and the impossibility of defending the ridge at a reasonable cost are described.

Shingle and sand derived from the erosion of the cliffs in Suffolk travel southwards, and at Bawdsey were retained by the works of sea-walling and groynes erected by the author, so that the overflow of the sea on to the marshes behind the clay cliff was effectually prevented.

The system of groyning adopted by the late Mr. Edward Case is referred to, and a comparison is drawn between the effect of groynes built at the lower end of the Dymchurch sea-wall and that of similar groynes on the sea frontage of the New Romney Marshes. At Dymchurch the effect of the groynes in accumulating sand and arresting the erosion at the foot of the apron of the sea-wall was entirely successful, but on the New Romney frontage the groynes, which were not carried up above high water, there being no sea-wall there, did not intercept the movement of the shingle beach and therefore did not afford the necessary protection to the shore. They were, however, afterwards extended, and produced good results.

The author has for many years been engaged in erecting groynes and other works on the shore between Worthing and Shoreham Harbour, a distance of about 4 miles. Part of this distance is protected by a ridge of shingle similar to that described between Blakeney and Weybourne on the Norfolk coast. In addition to the groynes a timber barrier was erected along a part of the ridge of shingle where the old groynes had been erected; these had been neglected, and the sea was rapidly transporting the ridge landwards. Wave screens, consisting of piles spaced apart, were also built in those parts where the greatest trouble was experienced in preventing the advance of the sea.

These groynes and other works have succeeded in arresting the advance of the high-water mark of the tides. Under the conditions the construction of a masonry sea-wall was impossible owing to the cost. Sections of certain parts of the shore are shown where the accumulation of shingle in course of time has been so great that no further works such as a sea-wall, revetment, or breast-work have been required, and the advance of the sea has been stopped.

Similar groyning work was carried out by the author on the frontage of the parish of West Wittering, east of Chichester Harbour, extending over about a mile of coast. The groynes here also have caused so great an accumulation of shingle during twenty years that the low cliff, which at one time was washed by the sea, is now in parts scarcely visible, and the ordinary high-water mark of spring tides has been driven back 60 ft. to 90 ft. No sea-wall, revetment or breastwork was built. The result is that an area of about 8 acres has been added to the frontage. The movement of drift on this part of the coast between Selsey Bill and Chichester Harbour is the reverse of that which prevails generally on the south coast, due to the protection afforded by the Isle of Wight from south-westerly gales.

In all works of sea defence groynes are of first importance. Where cliffs exist well-defined groynes can be made sufficient for the protection of the coast. The alignment of groynes should have reference to the direction of the prevalent winds or winds that cause the most powerful waves. The supply of littoral drift is augmented in some parts to some extent by the movement of shingle, sand, &c., below low water.

Three kinds of encroachment of the sea are described: The encroachment by erosion of cliffs high and low. The encroachment by erosion at the foot of sandhills—this is similar to the erosion of cliffs but not so perceptible. The encroachment by the gradual advance of a shingle bank where the land behind it is below high-water mark and is more or less defended by the bank. In support of the suggestion that movements of shingle, sand, &c., take place below low water, the existence of various banks along the south coast is noted, from which it is thought that supplies may be transported during heavy gales and finally washed up to replenish the shingle beaches which lie above low water.

The author has endeavoured to show that in most parts sea-walls must be supplemented by groynes; that under certain conditions groynes can be so devised as to afford sufficient protection to the shore; and that such groynes will arrest the encroachment of the sea, without the necessity of constructing other works.

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* Abstract of a paper to be read before the Institution of Civil Engineers, on Tuesday, November 20, 1923.

Canadian Lighthouses.—According to *Canadian Machinery* the lighthouse on Partridge Island, St. John, N.B. is to be electrified. This conversion from oil to electricity is the first to be carried out in the Canadian lighthouse service.

Cotton-Growing in Spain.—A Spanish Royal Decree—effective for five years—has recently been issued, states the Madrid correspondent of the Anglo-South American Bank, providing for an annual credit of Ptas. 2,000,000 to assist in the development of cotton cultivation. A previous step towards the production of home-grown cotton was the establishment last June of a Commission for the encouragement of its cultivation.

The World's Peace.—Sir Robert Hadfield has communicated to us a copy of the telegrams he exchanged a few days ago with the *New York World*. The executive editor of this American journal cabled, asking whether the nations were in closer accord; whether they were coming closer; what was their greatest need and how might this best be secured? In the course of his reply, Sir Robert stated that if America had backed up England and France after signing the Armistice and the Versailles Treaty, Germany would not have tried on her crafty tricks from which the whole world has been suffering for the last three years. If America now came forward and took her share in the world's troubles, and did not stand aloof, then the nations would be in closer accord. America shared in the results of victory, and her lot would not have been a happy one had the Hun won the contest. The great need of the day was peace and quietude amongst all the nations, but this could not be obtained whilst the greatest portion of the Anglo-Saxon people remained out. Sir Robert asked the editor to note the strong attitude taken up by the Dominions, Commonwealths and other outlying parts of the British Empire, who, he believed, were with us to a man.

"THE CAUSES OF RAPID CORROSION OF CONDENSER TUBES."

To the Editor of Engineering.

Sir,—As we experienced very serious trouble some ten or twelve years ago from corrosion in our condensers, I have read the paper by Dr. Bengough and his colleagues, as reported in your issue of the 2nd inst., with more than ordinary interest.

I must, however, take exception to the statement made "that the problem is more the concern of the chemist and metallurgist rather than that of the engineer." I quite agree that protector blocks of iron, steel, zinc, or aluminium have little or no effect in checking the action, due to the very low voltage and current which they generate, and this in a rapidly diminishing degree as they polarise, but where unlimited supplies of current from an outside source at the rate of 3 amperes to 5 amperes per 1,000 sq. ft. of surface to be protected can be applied, there is no question as to the protection which can thus be afforded.

If the tubes of the condenser are electrically bonded to the ferrules and tube plate, the anodes properly insulated and the installation is continuously operated and intelligently regulated, particularly if it is applied to a new condenser before corrosion has been allowed to start, then I maintain that so protected it will be rendered practically immune from corrosion trouble, or at least the progress of corrosion will be retarded to such an extent as to render its consequences almost negligible.

About twelve years ago at our power station, Southwick, we experienced corrosion trouble in a most acute form, and with a new or newly tubed condenser serious failures occurred at frequent intervals through pitting of the tubes after only three to five months' service, and in nine to fifteen months they all became so rotten as to require entirely retubing. As a last resort we installed an electrolytic system of protection, and since then we have been practically immune from trouble.

We use a current density of about 5 amperes per 1,000 sq. ft. of surface. The condensers are tested for leakage three times a day, and the working of the motor-generator plant with the instruments controlling it are carefully watched, adjusted and logged by the engineers in charge.

A few years ago eight experimental condensers installed by the Corrosion Committee of the Institution of Metals and under the supervision of Dr. Bengough were worked continuously under service conditions at our power station. Each of these condensers had tubes made of various alloys supplied by different makers. A bye-pass from our ordinary condensing system was circulated continuously through the tubes, whilst hot water from the boiler feed system was circulated on the steam side of the condensers in order to maintain as far as possible the working conditions of a main condenser as regards temperature corresponding to the vacuum at which it would be worked.

Each condenser had 12 tubes. One of these was taken out every three months and the tube hole stopped. The water which we used was ordinary sea water from the river estuary of Shoreham Harbour, contaminated to a certain extent by sewage and trade effluents which cause it to be a more corrosive mixture than ordinary pure sea water. Each tube, as it was taken out, was sawn in two and carefully examined, and I understood from previous papers read by Dr. Bengough on the subject that the life of the tubes made of the best of the alloys then tested was not likely to exceed three years.

All these experimental condensers were working without any protection, but in the case of two condensers steel pegs were inserted in the water ends as protectors, but these very rapidly wasted away to needle points, when their action, if any as such, ceased. Concurrently with these tests I obtained four full-length tubes of the same alloy from four of the makers who supplied the tubes for the experimental condensers.

These were inserted in groups of four at four different points, top and bottom, in one of our main condensers attached to a 3,000-kw. turbine, they were carefully bonded and protected by the electrolytic system, and at the end of two years the tubes from this condenser running under protection showed little or no signs of active corrosion compared with similar tubes in the experimental condensers running unprotected.

Before the protective system was applied to our main condensers the doors and cast-iron water ends used to graphitise very badly. They were in such a condition after two years' service that a penknife could be inserted ⅛ in. to ¼ in. into the surface just as if into soft fossey chalk. Shortly after the protective process was applied all this graphitised metal scaled off in great flakes and ultimately the surface became quite clean and free from oxide, and to this date they are still running in that condition without painting.

As an experiment I drilled a ⅛-in clearance hole in the division plate of one of the cast-iron condenser doors running under protection. In this I inserted an ordinary steel bolt and nut, absolutely free from grease or paint, just taken out of the stores. The nut was screwed on by hand and it was left in the condenser for twelve months untouched. During that period of constant service the bolt, nut and screw were covered with a fine film of oxide deposited from the anodes. Without any force the nut was screwed off and the nut, bolt and threads were just as clean as the day they were taken out of the stores, and had lost no weight. A similar bolt left in running sea water became a reedy mass of rust in less than three months.

To show my confidence in the electrolytic system I tried a further and very drastic experiment by placing four solid-drawn steel bicycle tubes of the same diameter and gauge as the Admiralty mixture condenser tubes in the same main condenser. These were disposed in four different positions, top and bottom, similar to the full length experimental non-ferrous tubes which were running under protection. These steel tubes were packed in the ordinary way, but instead of using brass ferrules I had special steel ferrules made for the purpose.

These were screwed into the rolled brass tube plate, and after being run under service conditions for twelve months, the tubes and ferrules were taken out, and beyond their being coated with a slight scale of protective oxide about the thickness of a piece of thin paper, they were practically in the same condition as on the day they were first inserted in the condenser. No corrosive action had taken place between the steel ferrule and the brass tube plate. A piece of brass of the same quality as the tube plate was drilled and tapped with a gland, and a short length of Admiralty mixture condenser tube was packed into it, but with a steel ferrule and left in running sea water the same as was used in the circulating system, and at the end of three months the ferrule was just a rusty mass of corruption and the tube plate badly corroded.

In my opinion the results of the very lengthy investigations which have taken place in connection with this important matter have so far furnished us with very little information which is of any practical service to those, like myself, who are in charge of large power plants afloat or ashore, and who have to continually contend with this very serious trouble of corrosion.

I have no hesitation whatever in stating that so far as present knowledge goes the only method of overcoming, or at least substantially minimising, the trouble, is to instal a system of electrolytic protection, and as a matter of insurance this should be done with every new condensing plant when first put into service, wherever there is the slightest suspicion of the circulating water being of a corrosive character.

If this is done, tubes of quite indifferent quality will be found to give satisfactory results and reasonably long life. There is no use waiting until the trouble starts and then installing the protective system; it should be applied right from the start when the film of oxide which is deposited from the anodes will give the necessary protective skin.

The adoption of this system of protection to condensers is also undoubtedly an additional safeguard against failure of turbine blading, as it will to a very large extent prevent boiler priming, which, due to the concentrated solution usually found under seagoing conditions in the boilers when condensers are leaking, is the prime cause of trouble with the blading often attributed to erosion, but really due to corrosion arising from this cause.

I cannot see how tubes made of any particular alloy are ever likely to give immunity from corrosion. Some are undoubtedly better than others according to purity, but even were they made of pure gold the process of drawing them must cause the molecular structure of the metal to become fixed in varying degrees of hardness. Where this condition exists, if the tubes are immersed in an acid or alkaline solution, an electrolytic couple between adjacent molecules is formed, and the harder molecule being electro-positive to the softer of necessity must waste away.

I consider the only common-sense cure is to superimpose a relatively stronger current from an outside source through suitably disposed insulated anodes, using the surfaces to be protected as the negative pole with the same electrolyte common to both circuits, then the lesser current which is the cause of corrosion must assuredly be neutralised.

My experience with this trouble, now extending over many years, all goes to prove that it can be effectively overcome if the electrolytic system of protection is efficiently applied and continuously operated, and that the structures to which it is fitted with a view to protection are suitably designed to allow of the necessary anodes being inserted in the most suitable positions to ensure the best results being obtained. All this seems to be a matter for the engineer to decide rather than the chemist and the metallurgist, but when they can find a more suitable remedy or alloy for condenser tubes which is indefinitely immune from corrosion under all service conditions at a price which is not prohibitive, no one would be more pleased to substitute this remedy for the electrolytic system of protection than myself. Up to the present, however, in our particular case it is the safest and surest preventative that we have yet been able to find.

Yours faithfully,

John Christie, Engineer and Manager.

Electricity Works, North-road, Brighton.

November 12, 1923.

AUXILIARY MACHINERY FOR DIESEL-ENGINED VESSELS.

To the Editor of Engineering.

Sir,—I have read Mr. Love's paper, to which you refer on page 568 of your issue of the 2nd inst., with great interest and may say that I am a strong advocate of electrically-driven auxiliary machinery for both engine room and deck use. The motor ship Pinzon, fitted with "Beardmore-Tosi" Diesel machinery, of which I am chief engineer, is equipped with electrically-driven engine room and deck auxiliary machinery, and during the last fourteen months this machinery has been in constant use without giving the slightest trouble. I am quite satisfied that electrical plant is as reliable in sea service as the ordinary steam plant.

Regarding winches which in ordinary everyday use have to withstand heavy and rough handling, in the above vessel during the fourteen months, 12 voyages were completed between Liverpool and Spain, stops being made at four ports on the Spanish coast each voyage. During this time the electric winches have been in continuous service, and shore cranes have never been used for loading or unloading. The electric winches have done as hard service as any steam winch in existence and have seldom failed, any troubles have been of a minor character and were put right in a few minutes. Each winch has done approximately 1,500 hours' continuous service and no parts have required replacement. These winches have been operated by the labour available in the ports visited, and in some cases the men have never seen winches of the type before. It is most important that first-class motors be fitted for cargo winch use, as in my opinion the low-priced motor is the more costly in the long run. Further, for deck machinery the motors must be absolutely watertight. To instal steam-driven auxiliary machinery in a vessel propelled by Diesel engines is, in my opinion, stretching the motto "Safety first" rather too far, and for a ship taking fuel oil in the United Kingdom is doing away with at least 50 per cent. of the economy.

The following details in connection with the running of the above vessel will show the economy of electrically-driven gear:—Six winches running continuous for eight hours discharging fruit cargo at Liverpool, four gangs to each hatch, making two whips to each winch on the end barrels. Each whip consists of 18 barrels of grapes (18 cwt.), or five cases of oranges (12 cwt.). All ordinary lighting and 75 per cent. of electric heaters in use. For the above load one Diesel-driven generator was in use; output 200 amps. at 220 volts. The fuel consumed during the eight hours amounted to 30 galls., or 0·12 ton Anglo-Persian fuel oil. The generator engine in use was the No. 2 engine, which up to date has run 3,190 hours without opening up, except to examine the fuel valves after 2,900 hours' running, when they were found all in order; and examining and cleaning director valves after 3,100 hours. This engine on the above duty is developing full load output and is running splendidly.

Mr. Love is very generous in giving 0·35 ton per day for working cargo, and I can only assume he is giving a twenty-four-hour working day. It is always safer to give an eight-hour working day as mentioned above. I am not greatly in favour of air compressors driven direct by Diesel engines, and would much prefer them to be driven by electric motor. This would reduce the number of engines to keep in order. It is most essential to have at least three generating units even if one is capable of doing all the work other than when the manœuvring compressor is in use. You must have a standby, and then one engine can always be overhauled when time suits, and can be done in a thorough manner, without having to rush in order to have it ready in case the other engine gives out.

The small emergency compressor and dynamo should be driven by a semi-Diesel engine, started by compressed air, supplied by a hand-driven compressor, and it should be of sufficient power to supply current for the ordinary lighting and in addition a bilge or sanitary pump.

This arrangement would allow the engine-room to be completely shut down as regards the Diesel engines, on occasions such as lying in port and only requiring lighting. The idea of the exhaust heat boiler appeals to me, as a little steam would be very useful in cold weather to facilitate starting up, etc., and perhaps Mr. Love would kindly supply more details regarding it.

Taking "all-electric" auxiliary machinery from the marine engineer's point of view, it is the simplicity which appeals to him. When "finished with engines" is rung everything can be shut down until again required; there are no long, tedious "stand-bys," warming through, etc., and no need to bother about banked fires, etc. To be able to go down below, start up a generator and have all winches running in less than five minutes is, I think, an ideal condition. In conclusion, I can say that in my own experience, present-day electrical machinery is thoroughly reliable, and requires less attention and overhauling than the average steam auxiliary. The electrical gear can be easily kept in order by the ship's electrician. If every unit is given systematic attention there will seldom be any failures.

C. Naisbitt, Chief Engineer, M.S. Pinzon.

Liverpool, November, 8, 1923.

"X-RAYS AND ATOMS."

To the Editor of Engineering.

Sir,—In your issue for November 9 is a report of my recent presidential address to the Röntgen Society, which gives a very accurate presentation of what I said on that occasion. But about the middle of the middle column of page 598, the writer has partially misunderstood what I said, or intended to say. The portion referred to concerns the letters K L M. It would be tedious to make the necessary corrections here; and I must refer any reader interested to the printed version of my address, as shortly, I suppose, to be published by the Röntgen Society.

I should like to take the opportunity of thanking the writer for the care with which he has recorded most of my oral remarks at the time.

Yours faithfully,

Oliver Lodge.

November 13, 1923.

Copenhagen-Hamburg Air Service.—On October 16 the Copenhagen-Hamburg Air Service, which had been in daily operation since April 17, brought a quite successful season to a close, says the *Danish Foreign Office Journal*. Not a single mishap occurred, and of the whole of the tours arranged 92·3 per cent. were carried through, the cancellation of the remainder being entirely due to atmospheric conditions. This is regarded, adds our contemporary, as one of the best results of any of the European services this season. The distance covered was 90,000 km. (about 55,000 miles), the number of passengers carried was 410, and the total weight of passengers, goods and mails, came to 40·5 tons.

RAPID ROLL-GRINDING MACHINE.

CONSTRUCTED BY MESSRS. FRANK STACEY AND CO., LIMITED, ENGINEERS, BIRMINGHAM.

FIG. 1. END VIEW OF MACHINE SHOWING BRIDGE HEAD.

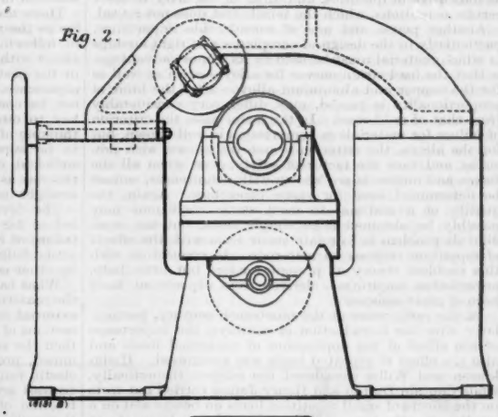


Fig. 2.

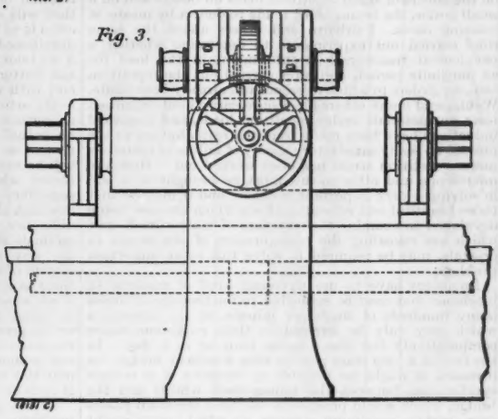


Fig. 3.

THERE is probably no class of work in which grinding is employed which has presented greater difficulties than the grinding of rolls of chilled iron or other hard materials for which a very high degree of accuracy is required. Rolls made of iron, steel, granite or porcelain, are used in various industries, the rolls often being very heavy and of correspondingly large diameter and length. In many instances they have to be finished to such truth that a pair of cylindrical rolls will be in optical contact with each other, light being invisible at any point along the line of contact, when a lamp is passed along the side of the rolls opposite to the observer. Sometimes, moreover, the rolls have to be finished to a cambered form with an equal perfection of workmanship. Accuracy of this kind can be obtained by the use of grinding machines of the type usually supplied for such duty by the leading makers, but only at the expense of speed of working, because the desired accuracy involves the employment of very light cuts.

Up till the present, grinding wheels for work such as we are dealing with, have always been carried on overhanging cantilever heads, capable of a horizontal traverse in a direction at right angles to the length of the roll being ground, such traverse being necessary for putting on the cut. The roll is, of course, moved backwards and forwards in the direction of its length, and is at the same time rotated on its axis. The nature of the support of the grinding wheel limits the cutting pressure which can be applied without causing the springing of the bracket. If the rolls were of equal hardness at all points of their surface a certain amount of springing would not be very serious, but uniformity of hardness is impossible to secure in practice, and a lack of rigidity in the wheel support is bound to produce differences in diameter of the finished work if any appreciable grinding pressure is used in the final cuts. For many purposes a difference in diameter of less than a thousandth of an inch in the length of a 5-ft. roll would constitute a very noticeable defect.

With a view to producing a machine which will permit of much heavier cuts than are at present possible while still maintaining the high degree of accuracy required, Mr. Frank Stacey, of Messrs. Frank Stacey and Co., Limited, Vauxhall-street, Birmingham, has recently developed the design illustrated in Figs. 1 to 3, above. The outstanding feature of the new machine is the use of a complete bridge, instead of a side bracket to support the grinding wheel. The bridge is a stiff deeply-ribbed casting, spanning the table which carries the work to and fro' beneath it. The feet of the bridge are held in strongly-proportioned cross-slides, in which the bridge can be traversed sufficiently to give the required feed motion to the grinding wheel. The device is extremely simple, but it is said to permit such greatly increased cuts to be taken, that the grinding of certain classes of chilled rolls can be carried out in one sixth the time required with machines of the ordinary type. In spite of this increase of speed the accuracy and finish of the work is at least as good as formerly obtained. The improvement, which is the subject of a patent, can be applied with advantage to existing machines provided that the beds and travelling tables are sufficiently substantial to withstand the heavy cutting which the bridge support of the grinding wheel makes possible.

THE TESTING OF MATERIALS.

IN his presidential address delivered on November 8 before the Birmingham and District Association of Civil Engineers, Professor F. C. Lea treated his audience to a rapid but thoroughly interesting survey of the art of the engineer from the earliest times to the present day. There is always pleasure in reflecting upon the achievements of men in the romantic and almost forgotten past, and the wonderful constructional triumphs they won in spite of an almost absolute ignorance of scientific laws as we now understand them. The pyramids and monoliths of the Egyptians, the magnificent irrigation works of the Nile Valley, the development of the arch by the Romans and the impressive aqueducts which stand to-day as ruined monuments to their engineering skill, all show how long ago constructional ability of the highest order was developed by civilised men. The Greeks shone rather in the artistic and intellectual sphere, and the Greek thinkers such as Aristotle, Archimedes, Pythagoras, left a mark which dominated scientific thought until Bacon, Galileo and Leonardo da Vinci placed scientific knowledge upon the only sure basis of experiment.

Professor Lea's object, in recalling the landmarks of the long road which engineers have travelled through the ages, was not merely to minister to the intellectual pleasure given by a good story well told, but to consider how far engineering progress has been dependent upon scientific research. He wished to cause his audience to reflect upon the ultimate tests of the truth of any scientific theories, and to what extent future development is likely to rest upon the application of those scientific methods which have proved so fruitful in helping men to understand and partially to control many of the phenomena of our external world. We much regret that Professor Lea's most interesting address is considerably too long for us to reprint *in extenso*, and that we must confine ourselves to quoting one section only, namely, that in which he deals with the state of modern knowledge concerning the strength of materials. This portion of the address was as follows :—

The subject of the testing of materials is of the greatest possible importance, and if time permitted, a great deal of interest could be written upon the methods of testing that have been introduced during the last fifty years, and of those whose names will be ever remembered with this important subject. Brevity makes it possible to mention only a few names, amongst which, however, are Bauschinger and Unwin, who, with others, have carried out tests on materials to determine not only those elastic properties upon which elastic theory is based, but to determine such fundamental properties as will indicate the suitability for any particular purpose and which will insure uniformity of properties in the various consignments of materials of a particular class.

In the case of mild steel it has been found that tensile strength, elongation per cent. and yield-point obtained from a single test, do give a very clear indication of the suitability of the material to meet the complicated conditions of stress that obtain in machine and structural elements. Careful experimental data are thus made to co-ordinate and supplement experience, but it is often overlooked that such tests are only indicative of quality of material, and experience has decided what qualities are necessary to meet the complicated conditions of practice.

It may be dangerous, however, to assume that similar

simple tests, such as are necessary and sufficient to indicate the suitability of mild steel for any purpose, will give confidence in the use of other materials, such for example, as the alloy steels, and thus in specifications for these materials it has been found necessary to introduce other tests, such as an impact test and a hardness number, as indicative of qualities, and thus of capacity to meet certain conditions, which the tensile test does not reveal.

Another point, and one of considerable importance, particularly in the design of aeroplanes and rigid airships in which material must be used to its utmost advantage, is that the load strain curves for alloys—steel as well as for the copper and aluminium alloys—after the limit of proportionality is passed, may differ very considerably from that of mild steel. In the latter case, the criterion of failure for materials in compression is well known, but for the alloys, the criterion is not yet known with precision, and thus the factor of safety, even when all the forces and moments are known with definiteness, cannot be determined even for static conditions. Again, the quality of a material to meet static conditions may possibly be obtained from simple tests, but the most difficult problem is to relate static tests with the effects of repetition stresses on materials. In connection with this problem theory at present renders but little help, nevertheless empiricisms derived from experiment have been of great assistance.

In the early years of the nineteenth century, particularly after the introduction of railways, the importance of the effect of the application of continued loads and also the effect of repeated loads was recognised. Hodgkinson and Willis considered the subject theoretically, while Captain Dalton and Henry James carried out tests on the effects of small repetition loads on beams and on a small girder, the beams being made to deflect by means of rotating cams. Fairbairn and others about the same time carried out experiments to determine whether a bar loaded transversely would maintain the load for an indefinite period, and later carried out the repetition tests on girders to which reference has already been made. Wöhler and many others have since carried out organised tests on materials under repetition loads, and empirical inductions have been made from the tests, but up to the present no really satisfactory theory of failure of materials under repetition stress has been worked out. Here the microscope and other means must be brought in to aid in solving a very important problem, and it may be that those beautiful and refined methods which are now being developed to examine the structure of matter itself, and which are revealing the configuration of the atoms in crystals, may be required to solve this most important problem.

Engineers have to use the same kind of material in machines that may be subjected to fluctuations of stress many hundreds of times per minute, or in structures which may only be stressed to their maximum value comparatively few times in an hour or in a day. In the case of a long train passing over a railway bridge, for instance, it might be possible to conceive of a certain synchronism between the rolling-stock wheels and the bridge, which would produce at the time the train passes over, certain maximum stresses, or which again might be repeated a number of times during the passage of a train. Again, a cross-girder may have maximum stresses produced each time a pair of wheels passes over it, providing the wheel loads are all about the same magnitude. It is possible that for the cross-girders as well as for the main girder, the maximum stress will occur only when the heavy wheel loads of the locomotive pass over the structure; the heaviest type of locomotive may only be passing over the bridge occasionally and long periods of rest may thus occur between the applications of the maximum stress. An aeroplane structure may only be subjected to maximum conditions of stress when performing some special manœuvre as, for example, when suddenly brought out of a nose dive.

Now all the evidence seems to show that as long as the range of stress to which a piece of material is subjected is kept within the safe limits, the number of repetitions that it will resist without fracture is indefinite, or at any rate is a very large number of millions. But, further, if this range of stress be exceeded, the number of repetitions required to break the piece seems to be within a wide range, at any rate, independent of the periodicity of the repetitions. Here, then, is a point with respect to the actual behaviour of materials under these repetition stresses that needs to be cleared up before we can satisfactorily know what is the ratio of a safe load sufficiently frequently repeated that will cause failure of a structure. This matter is very considerably complicated by the methods of connection that have to be adopted in structures, and also by the conditions producing the stress, whether by a blow or by a cyclically varying stress. Experiments which I have carried out on repetition stress show very conclusively when one element is gripped by another, for instance, when a specimen is held in a collet, the range of stress required to fracture the specimen where the abrupt change takes place from the specimen to the collet is very considerably less than the range of stress that will break it where there is no such discontinuity in form. Railway axles frequently fracture inside the wheel where there is a tight grip due to shrinking on, or fixing in some other way, the wheel on the axle. The same is true with respect to plates that are riveted together; at the point where there is a discontinuity of the one plate to the other which adjoins it, fractures take place earlier than in the freer part of the plate subjected to the same range of stress. Those who have had the duty of examining steel work on bridges have seen evidences of the effect of discontinuities in actual structures, and it may be that this question of discontinuities is really at the bottom of the conditions under which all material fails. No materials are perfectly homogeneous, and within a piece of material, that, so far as its external form is concerned, is continuous in section, there may be, due to the boundary conditions of crystals, the presence of small impurities and other small, though not observable, discontinuities, concentration of stress which finally leads to the failure of the material under repeated stresses of much less magnitude than those at which a perfect material might fail.

There are thus important points to be cleared up as far as the materials are concerned, and the only hope is in following those fundamental experimental methods allied with clear thinking which have been so helpful in the past. The laboratory must be the handmaid of experience. No investigation that adds to our knowledge can be considered too academic. We know where the key to our difficulties may at present be hidden. In thinking of new materials it is of the greatest importance to be sure that tests are introduced that will give sufficient information to warrant using such empirical theories as have been found reliable in connection with wrought iron and mild steel.

The development in our knowledge of materials has led so far in understanding the possible conditions of failure of machines and structures, but what will be the actual failing load of a structure or machine is complicated by other considerations.

What can be said with definiteness is that in so far as the materials are found to obey Hooke's law, then if the external forces and moments acting on the respective sections of certain shapes of structures, can be calculated, then the stresses acting on those sections can be determined, providing that the stresses are kept within the elastic range of the materials. For assumed loads the stresses are thus known, and these can be made some fraction of the stresses—whether static or repetitive—that will cause failure. But the real trouble in many cases is to know exactly how the forces and moments are distributed even within the elastic range. For example, if we take a built-up girder, consisting, let us say, of top and bottom booms and vertical and diagonal elements, and with all the elements at the respective joints perfectly articulated to each other, then the moments acting at certain sections should be definitely calculable. In an actual structure, the elements would probably be riveted at the joint, in which case the vertical members will be subjected to bending moments as well as vertical forces, while the boom elements will be subjected to secondary bending moments, which may increase or diminish the stresses due to the primary moment. The difference simply is that we have introduced by our methods of construction indeterminate conditions as to the way the forces and couples are balanced by the system of members. If we can make reasonable assumptions as to the degree of fixing at the joint, for example, if we assume that the joints are practically rigid, then by using what is known as the slope deflection method, or the general principle of Castigliano, both of which are mathematical deductions from elastic theory, the forces and moments can be determined, and the stress in the material can be obtained, providing again the loading is such as to limit the stresses within the elastic range.

In many cases, for example, of beams or walls, the properties of the sections of which are definitely known, the external moment and the forces may still be indeterminate, or it may be that they can only be determined approximately.

A typical example is that of the bridge, as, for instance, a railway bridge subjected to the rolling loads used on the railway, or a road bridge, which may be subjected to the rolling loads of different types of vehicles or the surging load of a crowd. Here the real difficulty is to determine to what extent the statical forces and moments are increased due to the impact effect of the moving loads. As early as 1848,* Professors Willis and Stokes investigated the effect of moving loads over beams, and but little was added to our knowledge of this subject until recent years, when the Public Works Department of India, and also a Committee of the American Society of Civil Engineers, carried out experiments; since the war, our own Ministry of Transport has done good service in drawing attention to the subject, and in carrying out certain tests which have been published in Major Mount's report. This report supplements the work already done in India sufficiently to show the need for further extended researches being carried out. This has now been recognised by the Department of Scientific and Industrial Research, and by the British Railway Companies, and a joint committee of investigation has been appointed. A programme of work has, as far as I know, not yet been published, and it will therefore not be out of place to discuss some of the problems that need investigation. The problem is not only of interest from the point of view of engineering theory, but has considerable significance in relationship to safety and economy. The usual method of procedure in designing railway underbridges in this country has, for a considerable number of years, been to reduce the possible wheel loads that may pass over the structure to some equivalent uniformly distributed load. For bridges of comparatively small span (say less than 100 ft.) it has been usual to draw up a table of uniformly-distributed loads that will give approximately the same bending moment as the actual wheel loads, and to design the structures from this data. The design data so obtained are only very approximate, and if applied to find shearing forces in girders of less than 80 ft. span, the errors might be of the order of 50 per cent.

There are reasons which we need not discuss here why this need not be important, but it will be sufficient simply to mention that it does not pay as a rule to change the thickness of the webs of girders, and that, therefore, except near the abutments, they are, for manufacturing reasons, generally made much stronger than is necessary. An attempt is sometimes made to approximate to the impact factor due to the rapidity of the loads and to the unbalanced forces of steam locomotives. The impact factor, however, is not only a function of the loads and the speeds, but must depend upon the form and elasticity of the structure, the nature of the path from the load to any particular part of the structure, and also upon the possibility of synchronism of oscillations with the periodicity of the recurring loads.

The important point is that at present the strictest examination of the wheel loads and unbalanced masses alone will not give the moments and shearing forces for which the structure must be designed; for that reason the theory is at present incomplete. But there are other conditions also which make the usual calculations only approximate; the methods of connecting the girders and the insertion of stiffeners rigidly connected to booms and web plates; stringers or tail bearers rigidly connected to the cross-girders, and thus not freely supported on spans equal to the distance between the cross-girders; the cross-girders themselves are partially fixed at the ends and these fixings not only reduce the stresses which are generally calculated on assumed conditions quite different from those obtaining, but they also introduce other stresses which are generally entirely neglected. Now it might be thought from all this that I am criticising the office methods adopted for calculating such bridges. Such is not the case, but what I wish to point out is that, if it is found by experience and direct experiment that the stresses obtaining in actual bridges are not those for which they were supposed to be calculated, the fault is not with theory as such, but that theory has been imperfectly or approximately applied. That leads me to the essential point I want to make. There is no doubt that structures should not only be designed on an elastic theory, but they should, in all conditions of working, be stressed within the range for which stress is proportional to strain for the given material. Towards the point of failure, the distribution of stress, as Navier recognised, may be quite different from that assumed in deriving the theory, but the real question we require an answer to, is, it seems to me, this: Do the stresses produced by the working loads equal those used in the calculations, and if not, is the theory wrong or are our assumptions wrong?

Now this—at least I hope so—is one of the questions that the committee I have referred to is attempting to answer. The stresses in structures can only, however, be inferred by measuring strains and assuming Hooke's law, and it is to be hoped that the strains produced in parts of structures when any system of loads is at rest and pass over at various speeds will be investigated and carefully compared with those obtained by the simple theory generally used. But before this is done, I am strongly of opinion that a good deal of fundamental pioneer work should be done in the laboratory. The strains produced in girders designed according to the ordinary theory and then stiffened in various ways should be investigated under laboratory conditions.

Already sufficient data have been gathered in our own laboratories in connection with experiments on elements for rigid airships and for metal aeroplanes, to show that the elastic theory, whenever rigidly and consistently applied, is trustworthy, and apparent inconsistencies are accounted for by deviations in the experiments from the assumed conditions of calculation, unstable forms particularly in compression, and what may be called secondary and higher orders of stresses.

The question is by no means an easy one, but it can be solved much more completely than at present by combined experiment and analysis. For future progress in metal structures such as bridges, airships and aeroplanes we require not less, but more, theory based upon further experiments directed to determine how far structures deviate from the conditions assumed in their design, and what are the real criteria of failure in materials. Rigid applications of the scientific method, principally in the laboratory, supplemented by observation on the larger scale of engineering experience, will lead to more complete solutions of these problems.

* Report of the committees appointed to inquire into the application of iron to railway structures.

GALICIAN-CANADIAN POLE TOOL FISHING METHODS.*

By Albert Millar, A.M.I.Mech.E. (Member).

"Fishing" in oil well nomenclature covers a great variety of work, and does not merely represent the recovery of lost tools as is often thought to be the case. Sidetracking of tools or casing also come under the heading of "Fishing." When a complicated fishing job is in progress it will be found to be a very good plan, before commencing operations, to draw to scale the probable position in the borehole, taking, as a basis, diameter of casing, dimensions of lost tools, measurements of depths, and impressions obtained. This enables one to form a much better idea as to what has happened, the type of tool to be selected, and its construction. As work proceeds and the position becomes clearer, revised sketches should be made and the dimensions of the fishing tool being used should be noted by the side of the sketch. In the event of the misfortune occurring to lose a tool whilst fishing, the situation can be immediately dealt with.

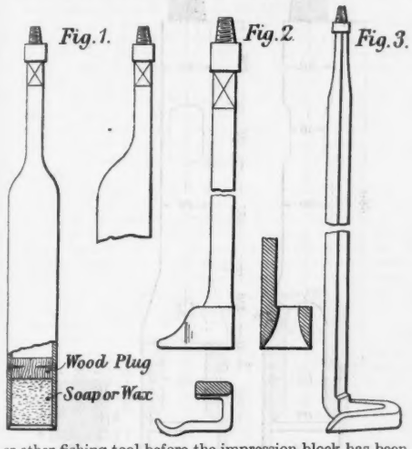
It should always be borne in mind that, at the best, fishing is carried on in the dark, therefore it is most important that every possible detail should be noted and recorded on paper instead of trusting to memory. If, in addition to making sketches, the possible position in the borehole is reconstructed on the surface, a still better idea as to the best method of procedure will be obtained.

* Abstract of paper read before the Institution of Petroleum Technologists, on November 13, 1923.

This is done by taking a length of casing of the diameter being fished in, and duplicating the position in the borehole as far as is known from impressions taken, this also facilitating the construction of the type of fishing tool required.

The engineer-in-charge, as well as the driller, should know the exact length, size, and weight of the string of tools in use, as well as the length and other measurements of each piece of casing in sequence comprising the working column. Should the drill pin break, the length from cutting edge to shoulder is ascertained at once, and in the event of casing pulling apart or breaking off, the length of the piece, or number of pieces contained in that part of the column which has parted, is precisely known.

Before commencing actual fishing operations the distance between the top of the casing and the object being fished for should be accurately measured and checked; time taken in measuring is not time lost but time gained in the long run. An impression block can be run at the same time as measurements are being taken. For this purpose the impression socket shown in Fig. 1 below (containing from 6 in. to 10 in. of soap or wax), should be of as large a diameter as the casing will allow, and from 5 ft. to 6 ft. long. This socket can also be made to work eccentrically, and should be run until a well-defined imprint has been obtained, as on this depends the type of tool to be employed. Only in the most simple of cases is it permissible to lower in a socket



or other fishing tool before the impression block has been run. It is, however, by far the better and safer course not to commence fishing before taking an impression and accurately measuring the distance. The right kind of tool has then to be selected to cope with the situation. Should this not be in stock, or if it cannot be constructed in the well smithy, then it is advisable to suspend operations until it has been provided. Makeshift tools are dangerous and should not be used.

Lost Tools.—Little or no difficulty is experienced in the recovery of tools which have become unscrewed during drilling, except in the following cases:—

When the driller has not detected that his bit has become detached and continues drilling on it, then either of two things are liable to happen. If he is drilling in soft strata, the lost tool will be driven off to the side; should, however, the formation be hard, a head will be formed on the lost tool, which may attain such dimensions that there will be no room left to pass a socket over it.

When the bit has been driven off into the wall, a hook instrument (wall hook), as shown in Fig. 2 or Fig. 3, should be used to catch hold of, and to pull, the lost tool into the centre of the borehole to enable it to be grasped by the socket. The shape and dimensions of the hook vary with individual cases, according to the size of the borehole and the tool to be pulled into position.

In cases where a head has been formed by continued drilling on the bit after it has become detached, the best procedure is to file the head off. This work can be accomplished in a few hours, and any good smith can construct the file or rasp tool. The width of this file or rasp is generally from 4 in. to 7 in. wide and from 6 ft. to 12 ft. long, tapering gradually and being slightly smaller at the bottom. The construction of the file depends on the size of the hole, tool and work to be done; the surface of the rasp tool is generally concave. This file or rasp is a most handy tool, and accomplishes a great deal of work in a short space of time. It should be constructed from good material, which is not brittle, and "springiness" is a most essential factor. After the lost bit or sinker has been pulled into the centre, or the head filed off, a socket may be lowered in. The best type for this work is the split taper socket (horn socket) fitted with one or more dogs, as shown in Fig. 4. The bottom of the socket should be cut off at an angle and the point or apex should be to the inside. It is possible to recover objects lying to one side of the borehole with this tool.

When, as is sometimes the case, the tools defy recovery, they can be sidetracked—*i.e.*, drilled off to the side. The best tool to use for this purpose is the "hoof bit" dressed at an angle of 45 deg., as shown in Fig. 5. Before drilling off to one side is commenced, a filling of hard rock or broken-up cast iron, such as firebars, &c., should be tamped in, this retarding progress, and giving the bit a better chance of thrusting the tool "off." It sometimes happens that bent tools are straightened out by

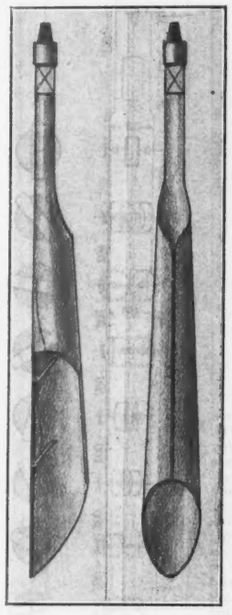


Fig. 4.

drilling alongside trapped tools, as the clays, sands, or cavings can be worked out and flushed away at the same time. Tools are more liable to become stuck in some clays than in others. These are generally classed "sticky clays." When this happens it is advisable to remove all water from the borehole with a suction sand pump and to replace by oil. The clay then loses its adhesive qualities and drilling can be continued without difficulty.

Another method of recovering lost tools or broken-off bits lying to the side, and which cannot be dislodged by the ordinary means, is to drill on with a bit of as large a dimension as possible, until from 2 ft. to 10 ft. below the lost tools has been reached, depending on the length of tool to be recovered. After this has been done a wall tool can be lowered in to draw the tool into position, and to guide it into the newly-drilled hole, where it will remain in an upright position, so that it can be gripped by a tongue socket in the usual way.

Slightly Bent Tools.—Care has to be taken in the recovery of tools which have become bent; when they are only slightly deformed they can often be jarred into the casing, becoming straightened out during this process, but excessive jarring is liable to damage the casing-shoe and may give subsequent trouble.

Runaway Tools.—More difficulty is generally experienced in the recovery of runaway tools, as they become more or less bent, and trouble is often found in getting them to pass as a unit through the casing. The best plan is to unscrew them one by one—that is, the jars from the sinker and the sinker from the bit—but they are sometimes so deformed that even this is found to be an impossibility. The safest tool to use when unscrewing poles or tools is the taper die socket. Should

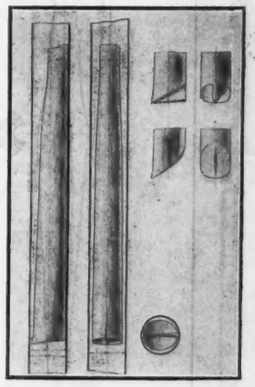


Fig. 5.

Fig. 6.

Fig. 7.

the tools be of small calibre—say, from 3½ in. to 4¼ in.—they may be cut up with a file, or a socket can be lowered in, a good grip taken, and casing with tools can then be pulled together (known as "stripping"). This is a tedious operation but not a risky one, providing proper care is taken.

When pole tools run away the poles generally become bent into all manner of inconceivable shapes, as shown in Figs. 6 and 7, or, breaking off several times, run down and become wedged together, rendering the fishing job still more complicated. The first thing to do in such cases is to count and measure the number of poles which they have recovered, then to measure the borehole very accurately to ascertain at what depth the top of the lost poles is standing. If measurements show that only a few feet are missing, then it can be safely assumed that the rods are intact as a unit, and the method of procedure is quite simple. After a socket has been let in, and a hold taken, the poles and tools will, in all probability, be withdrawn together. Should the well be a deep one, and it is found that some 600 ft. to 1,000 ft. are missing, then one can be pretty sure that the poles are badly twisted, or, what is more likely, that they have broken off after running away, possibly two or three times.

After a good impression has been obtained a tongue socket should be lowered in. When this has gripped upward jarring may be tried for a short time; should no progress be noted, then on no account should the situation be forced, as further pulling and jarring would only serve to wedge the poles more tightly together. The best thing to do is to unscrew the pole or poles one has got hold of, and after having done this, to lower in an impression block and get a fresh imprint of the situation, then either jar loose if advisable, or unscrew the poles one after another until direct communication can be made on to the tools. Should unscrewing by means of the socket prove impracticable, then a taper die socket should be employed with left-hand fishing poles.

It often happens that the uppermost pole is bent over in the form of a hook, and will not allow the socket being passed over it. In such a case a hook tool, as shown in Fig. 8, should be constructed which will pass between the pole and the casing. This is then lowered in, and when in place, a half-turn is given to it, and it is then slowly raised until contact has been made; by jarring and pulling upwards the pole can be straightened out and a socket used. Very often the hook will bring a number of bent poles with it to the surface. It is possible in practically every instance to fish a well clear of bent and twisted drilling poles, but should an exception to the rule occur, then the only thing left to do is to pull the casing and poles simultaneously, providing, of course, the poles and tools are tightly wedged inside the casing and the casing column is free.

Pulling casing and poles together (stripping) is generally a difficult process, and are apt to lead to trouble unless care and every precaution are exercised, because, when pulling casing with poles inside, it seldom, if ever, happens that the casing joints and pole joints are flush. Another means is to pull the casing to a point above where the lost object lies, then to drive the lost poles and tools into the wall of the borehole, using a hoof bit; as drilling proceeds the tools are cased off.

Broken Ropes.—Should the drilling or sand-pump line have parted, a rope spear is used, and it depends on the size of the hole whether a single spear, or a double or treble grab, is chosen. The spear is usually from 3 ft. to 5 ft. long, and a stout plate should be fixed directly above it of slightly smaller diameter than the casing. This prevents the spear being driven too deeply into the rope, which would most likely form a knot above the spear, thus preventing its withdrawal. When the rope has been grappled, the whole string can be withdrawn at a single operation, providing the tools have not become stuck in the meantime. Should the tools be imprisoned, the rope must be torn out in lengths until a

direct communication can be made on to the lost drilling implements or sand-pump.

Sidetracking.—In cases of lost tools or where tools are left in the borehole one alongside the other, the best thing to do is as follows: Take an instance of a set of tools having become stuck; drilling off to the side was commenced, a second string got trapped, and eventually a third, the hole being thus completely plugged. The total length of the three sets of tools can be taken as 35 ft. or more, and the borehole 6 in. diameter. To overcome the difficulty and enable the well to be deepened past the trapped tools, a good plan is to use a starting bar, as shown in Fig. 9, made as follows: About 75 ft. of 5-in. casing is taken of which 20 ft. to 25 ft. should be collapsed in the form of a wedge and then screwed into the remaining lengths, which should be filled in with loose stone and a wooden plug inserted at the bottom. When this is done, lower it into the well until it comes to rest on the obstruction, then withdraw the 6-in. working casing column up to 30 ft. or more above the top of the starting bar, and after a filling of stone has been put in, drilling with a hoof bit can be commenced. It will be found that a new hole can be drilled down and past the obstruction, which will not deviate from the vertical by more than 6 in. to 14 in. Owing to the use of the

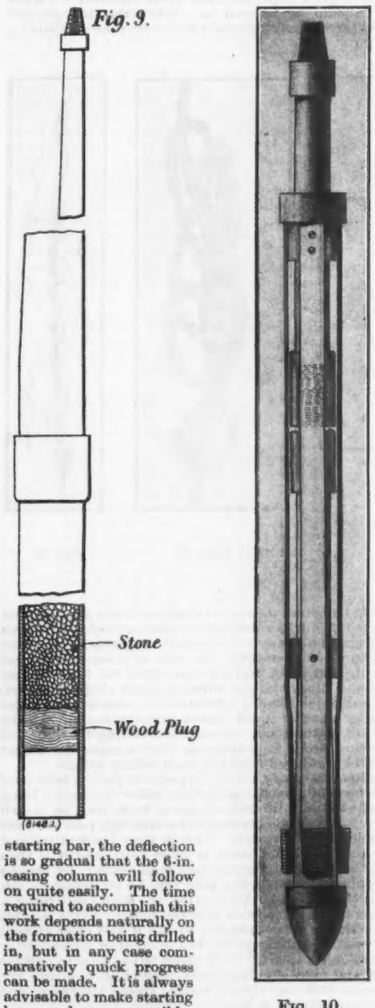


FIG. 10.

starting bar, the deflection is so gradual that the 6-in. casing column will follow on quite easily. The time required to accomplish this work depends naturally on the formation being drilled in, but in any case comparatively quick progress can be made. It is always advisable to make starting bars as long as possible.

Casing Accidents. — It sometimes happens that the casing shoe becomes detached, *i.e.*, it either comes unscrewed or it breaks off. There are three ways of overcoming this trouble:—

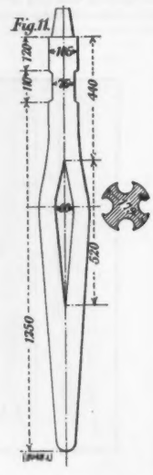
1. By screwing on again when this is possible.
2. By taking hold of the lost shoe with a casing spear, and pulling out the casing and the detached shoe together.
3. By drilling up the shoe.

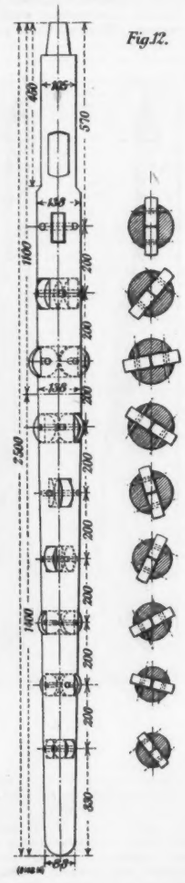
Screwing on to the shoe can only be done provided the thread has not been damaged and the shoe is standing upright. After connection has been made, the casing column should be withdrawn in order to control the joint and to ascertain whether the shoe has been properly and securely screwed on.

Should it be decided to take hold with a casing spear, a certain amount of care is necessary in the selection of the type of spear for this job; the "bulldog" type should not be used, but one that can be released at any time as desired. The manipulation of casing and tools simultaneously calls for much skill and resourcefulness, as previously mentioned.

The most simple and straightforward method is to drill the shoe up, especially if, as in Galician practice, the shoe is only from 7 mm. to 11 mm. thick. To do this, the casing shoe is first filled with stone, then the casing column is lifted some 30 ft. or more, until a window is left between it and the lost shoe. (The casing must, of course, be pulled and a new shoe screwed on before the work is restarted.) A hoof bit is then used of as large a diameter and as eccentric as possible. Drilling should not be forced at the commencement, as subsequent progress depends entirely on whether a proper start has been made. It is essential that the bit should work evenly, otherwise a thin strip of casing will be left behind which will give no end of trouble and retard the work. At the commencement the hoof bit (Fig. 5) should be kept as flat as possible, *i.e.*, it should be dressed at an angle of 5 deg. to 8 deg.; as work progresses, the angle is increased to about 30 deg. A suction sand pump will be found to be the best means of keeping the bottom of the borehole free of cuttings. If a few inches of these are permitted to accumulate, they will prevent progress altogether.

Lost Casing.—Casing lost through a joint nipple pulling out can easily be recovered, either by using a die nipple or by taking hold of it with a casing spear. This depends, however, on the type of casing being used.



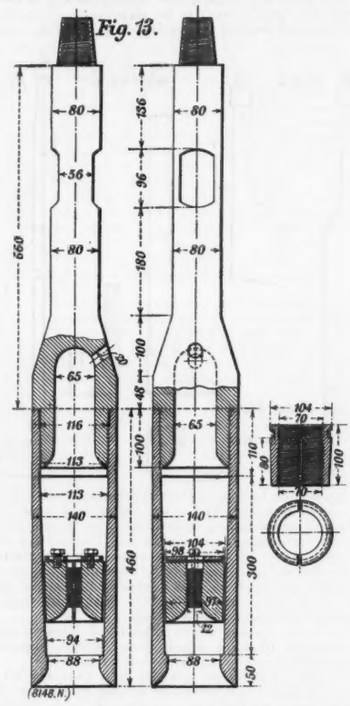


Runaway Casing.—Two thousand feet or 3,000 ft. of casing may run away a considerable distance without it suffering practically any damage, and its recovery proves quite a simple operation, whereas a shorter string of casing may fall only a few feet, yet become so deformed, torn up, and telescoped that it takes many months of fishing to clear the well. When casing has run away, and it has been ascertained that considerable damage has been sustained, careful measurements must be taken, and only after a thorough study of the prevailing conditions should a grappling tool be lowered in. A casing spear can be used if the casing is not split, but it is only advisable to use that type where the hold can be released as desired. If the casing is split, then it is better to use a casing socket, which is passed over the top piece and a grip taken on the outside circumference; or a combination tool can be used which will take a grip both on the inside and outside. When strips of casing present themselves, an ordinary tongue socket can be used with advantage. In Galicia, fishing poles of from $1\frac{9}{16}$ in. to 3 in. diameter are used for this kind of fishing, and are made with either right-hand or left-hand joints, depending on the work to be accomplished.

Frozen Casing.—When casing has become frozen or seized, it can sometimes be freed by releasing the casing dogs and allowing the casing to rest partly on its own weight, held only by the blocks and tackle, then lifting and again releasing. One must be careful not to allow too much slack, or the casing might be deformed. If this method is not successful, and it cannot be freed by jarring, tension fishing, or the steam method (see paper on "The Galician-Canadian System of Pole Tool Drilling,"* under "Fishing Instruments"), it may still be partially recovered by the following means:—

(*a*) By slitting the casing joint just above where it is known to have become frozen; the remainder of the column is then free and can be withdrawn. In some cases several joints have to be slit before a point is reached where the casing is free. If it is definitely known that only the casing shoe is frozen, it can often be freed by slitting it in two or three places throughout its entire length, starting just below the joint. The slits should be from $\frac{1}{8}$ in. to $\frac{1}{4}$ in. wide, and the casing shoe being then no longer rigid, can be pulled loose.

(*b*) When the whole length of casing cannot be recovered, and it is considered expedient that drilling should be continued with the same dimension, one can either sidetrack the lost part or drill it up. Whichever method is chosen depends more or less on the formation. If there is much hard rock it is better to drill it up, but if the walls of the borehole are moderately soft, one would be quite safe in sidetracking. The difficulty is in getting a proper start. Once this is made, it is surprising how quickly the work proceeds. For instance, $6\frac{1}{4}$ in. diameter casing of $\frac{5}{16}$ in. thickness can be collapsed and sidetracked at the rate of from 5 ft. to 10 ft. daily at a depth of, say, 4,500 ft., and the working column will follow on without much difficulty. The proper tool for this work is a specially-shaped hoof bit, and it is advisable to use a heavy sinker or even two coupled together. If the bit is properly dressed, not only will the casing be collapsed and sidetracked, but no under-reaming will be necessary to enable the working column to follow on easily. The hole should be well sand-pumped out after every run, and a filling of stone put in, so that the bit has



to work out the distance twice over. This goes quickly, and is not time lost but time gained, as one is quite certain that each foot has been properly worked out.

Complications Caused by Runaway Tools, Poles, and Casing.

Where tools, poles, and casing have run away, the operator must devise such methods and means as will suit this particular job, and no hard-and-fast rules can be laid down. Where tools and casing have run away, it is important to close the window between the two columns as quickly as possible, so as to avoid an accumulation of cavings forming on the top of the lost tools lying inside the runaway casing. The next thing to do is to run a swedge to make quite sure that the two casings are parallel with one another, and that the tools can be passed through them. An impression block is the next instrument to use, and if a number of poles have also run away, then it is better not to jar and pull, but rather to unscrew the poles one by one until the lost string of tools is reached, and these can then be fished out.

During fishing for the lost tools, it will have become apparent whether the casing has become bent or not; if it is found that the casing is only slightly deformed, or only to such an extent that it can be pulled through the preceding column, then a casing spear, as shown in Fig. 10, can be lowered in and a hold taken, after having controlled the casing with a swedge. It may be, however, that the runaway casing has become frozen meanwhile; to test this, the upper part of the parted column can be lifted 3 or 4 ft. clear of the runaway column and then a pull taken on the rods. If it is found to be free, then both columns, *i.e.*, both the free and the runaway sections, can be pulled together.

One is sometimes confronted with tools having become wedged in the casing either during letting in or pulling out. When this happens a little upward and downward jarring may loosen them, but under no circumstances should the situation be forced either way, as the casing is liable to become damaged. The best thing to do is to endeavour to pull the casing with the wedged tools together. Should the tools have become stuck in a frozen column, one should try to unscrew the casing

* Journ. Inst. Petr. Techn. VIII, No. 34, pages 617-665. December, 1922.

at a point below where the tools are wedged, and to pull casing and tools together, as previously mentioned. Should this not prove possible, owing to the casing being frozen above the point where the tools are stuck, the tools must either be wrenched loose or cut to pieces with a rotary cutter, the latter being the best and safest method.

Another frequent casing trouble is that known as "collapsed" casing, and it depends on the extent of the damage sustained as to the type of swedge it is advisable to use. If the casing is badly collapsed, it is better to use several swedges of progressive diameter, the plain fluted type, as shown in Fig. 11, being the best with which to commence operations. Once the casing is swedged back into something like its original shape and diameter, the roller type of swedge, shown in Fig. 12, should be exclusively used, as this is not so liable to jamb and does not abrade the casing to the extent of the ordinary swedge. The work should never be forced; if the swedge is driven through with undue haste, the casing is liable to collapse above it, making its recovery a difficult matter. A fishing socket to the use of which reference will be made later is shown in Fig. 13.

An Instance of Complicated Fishing with Pole Tools Arising from a Series of Mishaps.

The well in question was 4,040 ft. deep with 6-in. movable casing hanging free from the casing dogs, the casing-shoe being 33 ft. from the bottom.

Whilst withdrawing the tools, the forty-fifth pole above the drilling jars broke and the tools together with the 45 poles ran away about 680 ft. On the tools striking bottom, the third pole above the drilling bit broke and 42 poles ran down alongside the tools. Of these 42 poles the twentieth broke and ran down alongside the others, wedging them tightly. All the poles were extremely bent and cork-screwed. The condition of affairs is shown in Fig. 14*a*, and the subsequent figures show various stages of the work of dealing with the situation.

After an impression was taken, a tongue socket was lowered in and a hold taken on the length containing 22 poles, considerable upward jarring resulting in the recovery of five poles, the fifth having broken off just above the lower joint. It was at this point that the first mistake was made. Instead of measuring the borehole after the first five poles were pulled out, a socket was let in without any precautionary measure being taken, and instead of gripping hold of that length where the five poles had broken off, a grip was taken of the length containing 20 poles and upward jarring was resorted to. The longer they jarred, the more tightly the poles became wedged, with the result that the socket was left behind with jars, sinker and a further number of poles. A second socket was let in and jarring continued until the top pole of the 20 broke off, and this, together with the two sockets, was withdrawn. The socket was then let in time after time, and after several days' fishing there still remained 30 poles and the lost tools in the hole, these poles being in three separate lengths, tightly wedged one alongside the other.

When it was found impossible to get the poles out by incessant pulling and jarring, those in charge of the operations began, for the first time, to reconsider the probable position in the borehole, too late, however, to form any definite idea of the exact position of the run-away poles and tools. There now remained only one course to pursue, *i.e.*, to unscrew the poles one by one, always taking hold of the one which presented itself uppermost. This took a good deal of time, and eventually there only remained the string of tools connected to two drilling poles, plus one and three-quarter poles which had run down alongside. At this juncture undue haste proved a false step, and was the commencement of one mishap following another. Instead of continuing unscrewing until only the tools remained, the casing was lifted to allow the one and three-quarter poles to fall through. A fishing socket (Fig. 13) was then let in and a hold taken of the two poles connected to the tools, pulling was commenced, and, judging by the continued heavy pull which was required, it was evident the tools had become somewhat bent. During pulling, the poles broke and the whole thing ran back again, together with the fishing socket, plus two more drilling poles. Left-hand fishing poles of $1\frac{5}{16}$ in. diameter were then lowered in with a heavy fishing socket, by means of which the two poles, together with the lost socket, were recovered; after this hold was taken on the two drilling poles coupled to the drilling tools.

The work of pulling out went well until there remained only two left-hand poles (plus the lost tools and drilling poles) to be withdrawn from the borehole, when carelessness on the part of the driller's helper (due most likely to over-excitement) to screw on the pole swivel properly to the poles, resulted in the swivel and poles parting company when the next lift was taken, and the drilling tools with the two drilling poles, plus the socket and two left-handed fishing poles, ran away to the bottom. An impression block was now run which showed the pin end of a fishing pole standing vertically in the centre of the borehole. Heavy left-hand fishing poles were again let in, and a connection was made by screwing on; but, after considerable jarring and pulling, it was found that the tools would not budge. The poles were then uncoupled, and a die socket let in to unscrew the two left-hand poles which had run down. After making a connection and unscrewing, the die socket was withdrawn, but it brought only one left-handed fishing pole with it to the surface, leaving the second fishing pole in the borehole. The die socket was again let in, but no connection could be effected; therefore it was withdrawn. On an impression block being run in, it was found that instead of showing, as was expected, the pin of the second fishing pole standing vertically, the impression showed the fishing pole lying over to one side. An ordinary tongue socket was then let in which resulted in a piece of fishing pole some 6 ft. long being withdrawn from the borehole. The next impression obtained showed the substitute's pin, and the substitute was then unscrewed from the socket and pulled out. Further impressions showed the pin of the lost fishing socket, but no trace of the broken fishing pole. As the body of this socket was only $\frac{1}{4}$ in. smaller than the inside diameter of the casing, it was difficult to know where the six metres of fishing pole had got to, but by running a deeper impression block which would pass down at least to the shoulder of the socket, it was ascertained that a quantity of sand had collected on the top of it. A small indentation on one side of the impression block immediately gave the clue as to what had happened. The missing part of the fishing pole had been driven completely through the wall of the casing, and only the bent and broken end was protruding about $\frac{3}{4}$ in. inside. After using various hooks and spuds, the broken-off pole was pulled out about 1 ft. 8 in. into the casing, but owing to the angle at which it was protruding, it was impossible to get hold of it. The pole was then driven back until the broken end became practically flush with the wall of the casing.

A connection was made by screwing directly on to the

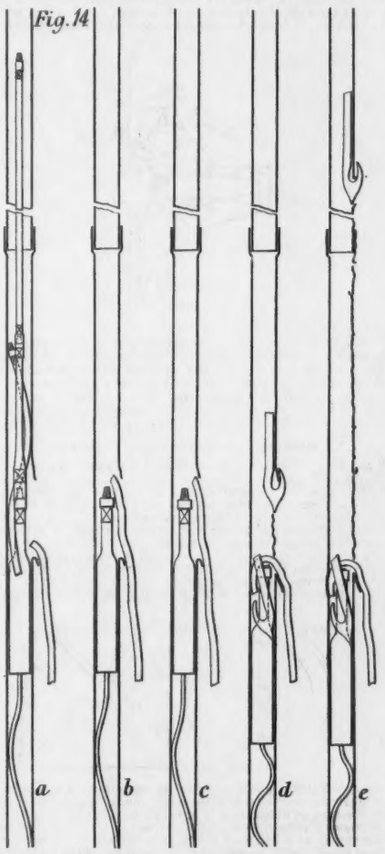


Fig. 14

fishing socket and upward jarring was commenced, which proved to be a very false step. After some fourteen days' continued upward jarring, the pin was broken off the socket, and no further headway could be made. It was then decided to try to drive the socket downwards, but instead of first making a connection on to it and driving from above by means of a pair of fishing jars, a driving bar was made, having an outside diameter practically equal to that of the inside diameter of the casing; this was lowered in and driving down was commenced. The depth at which the driving bar stood was not measured. After several days of heavy driving, which only resulted in the tools being driven some 2 ft. 6 in., the driving bar was withdrawn. An impression block was run in which showed an impression of the fishing pole bent in the shape of a hook and lying right across the borehole and over the top of the socket stem. What had happened was that, instead of driving on the top of the socket as was intended, the driving bar, owing to its fullness, had come to rest during lowering in on the broken fishing pole which was protruding slightly inside the casing, and on this they had been driving until it had become bent over in the manner described.

Under these circumstances, it was quite impossible to effect a connection with the fishing socket, and there was only one thing that could be done: to make a circular cutter to cut off the bent pole flush with the casing, and after having accomplished this, the severed portion could easily have been recovered, enabling a connection with the socket to be made again. Instead of this, a hook was constructed by which it was anticipated it would be possible either to withdraw the broken pole altogether or to straighten it out. The hook was duly lowered in, and after several hours of upward jarring it broke, and about 2 ft. of this hook was left behind.

This, however, did not prove a sufficient lesson, so a second hook was let in, which took hold of what was thought to be the bent fishing pole. After several days of progress was recorded, the hook was uncoupled and withdrawn, and after running an impression block it was discovered that instead of a hold having been taken on the broken pole, the hook had penetrated the casing at that point where the pole had gone through, and the 33 ft. of upward jarring had only resulted in slitting the casing to that extent. It was now that a further serious error of judgment was made, for instead of cutting away the pole and freeing the socket, it was decided to pull the casing, poles and tools together, the result being that the casing parted at a joint which had been slit.

An impression block was run in, became trapped and could not be recovered. During this process a half pair of fishing jars was also left behind. The decision was then come to that there was nothing more to be done, and the best course would be to drill alongside, or, in other words, to sidetrack some 136 ft. of 6 in. diameter, casing containing a bit, sinker and jars, two drilling poles, a fishing socket, 2 ft. of hook and impression block, and a half pair of jars, as well as the cause of the trouble—the broken fishing pole. The work of drilling past took over seventeen months to perform.

By this instance it will be seen how very easy it is for a simple fishing job to be converted into a serious fishing complication through lack of spending a little more time and concentrated thought at the outset, and by taking risks through undue haste to get the well cleared.

Had accurate measurements been taken in the first place, it would have been ascertained that the poles had broken in two places, and had run down alongside, thus becoming bent and wedged. Then, instead of pulling and jarring, the hole could soon have been cleared by the simple process of unscrewing whatever the socket took hold of. This would certainly have taken less time, and would have been the safest course to pursue.

After the impression block had been run and the borehole measured, a hold could have been taken with a suitable socket, and a little upward jarring tried, which would have tended, not only to straighten the bent poles, but also to loosen their joints. Unscrewing could then have proceeded until all the drilling poles had been withdrawn and only the lost string of tools remained, which could have been caught hold of and pulled out without much trouble.

During this fishing scrape the following errors of judgment are apparent, and were the cause of twenty-one months' costly and tedious fishing.

1. In not measuring the well after the removal of the first five rods.

2. In lifting the casing. This is always a step which should be given most careful consideration during fishing operations, as there is always the possibility of the walls of the borehole caving, or that the tools may fall off to the side, rendering their extraction a more complicated matter. Should the casing be lowered back again, there is every likelihood of the lost object being driven to one side and the casing becoming damaged.

3. The continued upward jarring after the broken fishing pole had been driven flush with the casing, and a direct communication was made on to the socket. It was obvious that in a case like this upward jarring would be of no use whatever, and could have no actual loosening effect, because underneath the socket were two drilling holes, which were more or less bent and cork-screwed, and which would serve to act as a spring; below the poles were the drilling tools which had become stuck, thereby acting as an anchor. It should have been evident that only one of two things could happen—either the drilling poles above the jarring bar would break, or else the pin would be jarred off the socket, as was the case (see "Jarring," "Galician-Canadian System of Pole Tool Drilling").

The best thing to have done in this instance would have been to let in $2\frac{1}{2}$-in. fishing poles and take a firm hold; then the tools could have been pulled together with the lost fishing socket by means of ordinary tension fishing. The end of the broken fishing pole which was protruding slightly in the inside of the casing would have been pushed flush with the walls of the casing, thus affording a free passage for the tools.

4. Driving the socket down. In the first place, the idea of putting in a loose driving bar was simply asking for trouble; and, secondly, taking into consideration the fact that below the socket were two drilling poles (total length, 72 ft.) which would act as a spring, what progress could be reasonably expected?

However, since it was decided to drive down, instead of using a loose driving bar, a connection should have been made with a taper die socket on to the implements it was intended to drive down; above this would be the fishing jars, followed by the driving bar. By this method there could have been no doubt of achieving the purpose aimed at.

5. When it was discovered that, instead of driving the socket downward, they had been simply bending the broken fishing pole over the stem of the socket, there was clearly only one course left open: to cut off that part of the pole protruding into the casing flush with the casing wall. The lowering in of a hook was a great mistake, especially as it was known that the casing had already been holed. The only kind of hook which could be used with any degree of safety in such a case would be of similar construction to the "bootjack."

6. Probably the most serious mistake of all was the decision to pull casing and lost equipment simultaneously, after it was definitely known that the casing had been slit to the extent of 33 ft., and that a joint had been cut through. The very fact of the 6-in. casing having in all

probability become deformed by the penetration of the fishing pole, and the possibility of difficulty being experienced in pulling the deformed 6 in. string through the 7 in. casing column, should have caused the utmost care and forethought being given as to the advisability of such an operation, quite apart from the fact that it was known that the 7 in. casing was deformed, a number of meters having collapsed during drilling operations, and having had to be swedged out. The parting of the casing at this juncture was in all probability the best thing which could have happened in the interest of the well in question.

CATALOGUES.

Rust Preventive.—Messrs. N. Taylor and Son, 17, Goree-Piazzas, Liverpool, have sent us a circular giving particulars of their preparations for preventing rust and also for case-hardening.

Electric Cables.—A catalogue of cables produced by Messrs. Sieverts Cable Works, Sweden, has reached us from Messrs. James McMillan and Co., Clun House, Surrey-street, London, W.C. 2, who are sole agents for Messrs. Sieverts.

Water Filters.—Large filters of the gravity and pressure types are the subject of a special catalogue received from the Becco Engineering and Chemical Company, Limited, 160, City-road, London, E.C. 1. Both types are illustrated and their principles and applications are explained.

Pyrometers.—A catalogue of pyrometers with much useful information and technical notes on the application of these instruments has been issued by the Foster Instrument Company, Letchworth, Herts. The pyrometers dealt with are of the thermo-couple type and they are suitable for works or laboratory practice.

Electric Cables.—A catalogue of single, twin and three-core cables sheathed with tough rubber and suitable for house, shop, office and general indoor wiring is to hand from Messrs. Johnson and Phillips, Limited, Charlton, London, S.E. 7. Dimensions and priced lists of the cable and of suitable fittings and connections are given.

Grab Dredgers.—Messrs. Priestman Brothers, Limited, Hull, send some interesting illustrations of grab dredgers they have built for home, Indian and foreign service since 1880. In the larger sizes the cranes lift 5 tons at each operation and discharge 800 tons per hour into the hopper. Some of the smaller self-propelled river dredgers with hoppers are favoured by foreign and Colonial Governments.

Portable Air Compressors.—Several designs of portable motor-driven air compressing plant are illustrated in a catalogue received from Messrs. Arnold Goodwin and Son, Limited, Southwark Bridge, London, S.E. 1. The plants are mounted on four-wheel trucks for hauling on road or rail as required, and are suitable for supplying compressed air for operating pneumatic tools used in road breaking, quarrying, riveting, &c. The engines driving the compressors run on paraffin, but electrically-driven compressors and portable electric generating sets are also illustrated.

Ball Bearings.—A self-aligning ball bearing, in which the balls run in a groove in the inner race and are free to adjust themselves over a spherical surface in the outer race, is illustrated in a catalogue of the S.O.R. Ball Bearing Company, 115, Southwark-street, London, S.E. 1, whose works are in Switzerland and France. These bearings have an adapter split sleeve which allows them to be slipped along the shaft and tightened in the required position. They are listed with dimensions and prices in sizes for ¾ in. to 4 in. shafts, and are supplied separately or mounted in plummer blocks, or hangers.

Valves.—Rose's patent valve for steam, water, oil and other fluids, is described and illustrated in a catalogue issued by Messrs. Robey and Co., Limited, Lincoln, who are the sole manufacturers. The valve box is set at an angle to the axis of the pipe line, and the arrangements are such that when the valve is fully open an unobstructed passage for the flow of the fluid is obtained. The valve faces are also protected from the scoring action of the fluid. A list of standard sizes ranging from ½ in. to 4 in. bore, in cast-iron and bronze, is given and, in both cases, the valves are made with flanged or screwed ends.

Colliery and Steel Works Plant, &c.—Some excellent examples of large scale machine, piping and constructional work are illustrated in three catalogues received from the Brightside Foundry and Engineering Company, Limited, Sheffield. The first catalogue shows steam and water piping, pumps, air compressors, and boiler-house plant, while the second deals with colliery plant including tub decks, three-deck cages, haulage gear, large fans, boilers and pumps, economisers and superheaters, &c. The third catalogue illustrates steel-making plant of the most powerful type for rolling, cropping, shearing hot blooms and slabs, pendulum hot saws, large lathes, presses, steam hammers, riveting, bending and other machines. Nearly all this work is carried out on a large scale; but, when fitted up completely, full attention is given to the smaller details.

THE NEWCOMEN SOCIETY.—The annual general meeting of this society will be held in Caxton Hall, Room 13, on Thursday, December 6, at 5.30 p.m., when, at the conclusion of the business, Mr. Ivor B. Hart, B.Sc., member, will give a paper on "The Dynamics of Leonardo da Vinci."

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACTS OF 1907 AND 1919.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the communicators are given in italics.

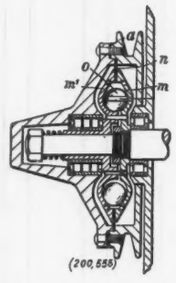
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 1s.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Acts.

ELECTRICAL APPARATUS.

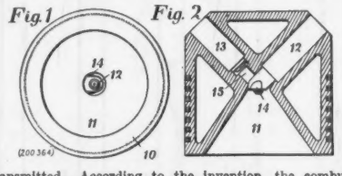
200,555. E. W. Collingham and C. J. A. Owen, Beeston, Nottingham. Electric Generators. (1 *Fig.*) September 5, 1922.—The invention relates to centrifugally-controlled friction driving mechanism employed to drive an electric generator at a fairly constant rate, when the power is obtained from an engine, such for example as that on a motor vehicle, which is necessarily run at widely different speeds to meet the road conditions.



According to the invention, the driving pulley *a* is formed with an interior annulus *n* which is gripped between the outer edges of two friction discs *m*, *m*1. The latter are formed so that balls *o* can be disposed between them, and the outward pressure of the balls due to centrifugal action tends to separate the friction discs and disconnect the generator from the pulley when the speed becomes excessive. (*Accepted August* 1, 1923.)

GAS ENGINES, PRODUCERS, HOLDERS, &c.

200,364. North British Diesel Engine Works (1922), Limited, Whiteinch, Glasgow, and J. C. McC. Maclagan, Drumchapel. Internal-Combustion Engines. (2 *Figs.*) July 13, 1922.—The invention relates to cylinder ends or covers for internal combustion engines, particularly applicable to two-stroke cycle engines of the kind in which a moving cylinder is guided at its end or ends (depending upon whether it is single or double acting) on a combustion head or heads supported from the engine framing. As hitherto constructed this combustion head (or heads) has two openings through it, one to receive the fuel injection valve and another through which the starting air



is transmitted. According to the invention, the combustion head 10 is constructed with the usual conical combustion space 11 in the apex of which there is provided an aperture to receive the inner end of a fuel injection valve casing 12. A valve 13 controlling the supply of starting air is held in a passage in the combustion head cover 10 and the sides 14 of the inner end of the fuel-injection valve casing 12 are flattened or grooved. An opening 15 leading from the passage holding the starting valve 13 communicates with these grooved parts 14. There is thus only one aperture through the apex of the combustion space 11 for the admission of both the oil fuel and the starting air. (*Sealed.*)

GUNS AND EXPLOSIVES.

199,055. Vickers, Limited, Westminster, London, and A. L. Perham, Westminster, London. Control Systems for Gun Mountings. (2 *Figs.*) December 16, 1921.—The invention relates to means for electrically controlling guns, searchlights, rangefinders, &c., from a distance, in which an electric hunting device comprising receiving and following members A, B and a switch C, C1 acts through an electromagnetic relay *e*2, *e*2*x* to move the control valve E of the gun, &c. According to the invention, the receiving member A is purely rotary and the relay is connected to the switch-plate C, so that movement of the relay acts upon the switch to break the circuit and stop the relay's own movement, means being provided whereby the ratio of relay movement to relative displacement of receiving and following members decreases as the latter movement increases. The receiving pointer A, driven by a distantly-controlled electric motor A1, is displaced relatively to a following dial B connected with the gun, &c., by a geared shaft *b*. The dial B pivotally carries a switch-lever C1, one end of which engages a cam D on the pointer A, the other end moving relatively to a gap in the contacts on the switch-plate C. The switch-plate C is normally rotated with the shaft *b* by means of a projection on a sleeve G1, which embraces the hub C2 of the plate and engages a straight slot *c*2 in the hub. When, however, the valve E is moved by the relay, a lever G translates the sleeve G1 and the pin engaging a cam groove *b*1 on the shaft *b* rotates the plate C relatively to the dial B to restore the switch lever C1 to the gap and stop the relay. The cam D which is cut from soft material is so shaped that, as the movement of the pointer A relatively to the dial B increases, the resulting relay movement decreases. The valve E is operated from the relay by a piston E1 working in a cylinder E1X, the space above the piston being always open to fluid pressure, the space below being alternately put to pressure or exhaust by the actuation of one or other of the needle valves *e*3, *e*4*x* effected by the armature *e*5 of the electromagnets *e*2, *e*2*x*. When the valve E is rigidly connected with the switch-actuating lever G, the dial B lags behind the pointer A. This lag is prevented by removing

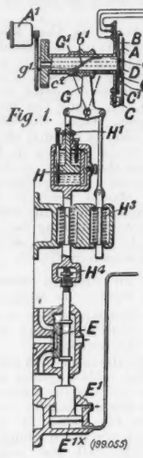


Fig. 1.

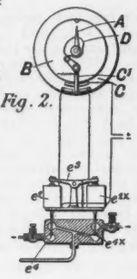
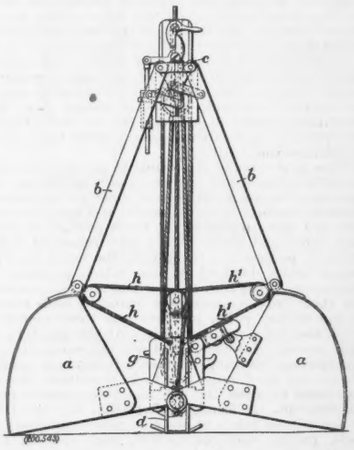


Fig. 2.

a pin H1 so as to insert an adjustable dashpot H in the connection between the valve and the switch. Further, to prevent lag due to the lap of the valve E, a lost-motion coupling H4 and a centring spring H3 are inserted between the valve and the switch. (*Accepted June* 27, 1923.)

LIFTING AND HAULING APPLIANCES.

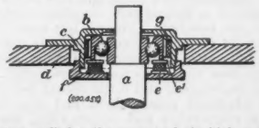
200,543. H. McD. Cooper, Ilford, and H. B. Willmott, Barking. Grabs. (8 *Figs.*) March 7, 1922.—The invention is an improved lifting and dumping or ring discharge grab, and relates to grabs in which the bucket halves *a* are hinged to a cross-beam *d* and suspended by a pivoted link bar *b* from the top frame or head *c* of the grab, the sliding pulley block or hook carrying crosshead *g* of the grab being provided with means for



guiding it into interlocking engagement with the hinge cross-beam *d*. According to the invention, flexible guiding means, such as ropes or chains *h*, *h*1, are provided for guiding the sliding pulley block or hook carrying crosshead *g*, provision being made for keeping the flexible guides under proper tension as the cross-beam *d*, to which the buckets are hinged, is raised and lowered. (*Sealed.*)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

200,452. The British Thomson-Houston Company, Limited, London, and F. H. Clough, Hillmorton, near Rugby. Ball Bearings. (2 *Figs.*) April 20, 1922.—The invention relates to ball bearings for high speed spindles of the type in which the bearing is able to move laterally (in a direction perpendicular to its axis) to enable the spindle to take up a fresh position and so damp out oscillations at high speeds. According to the invention, the walls of the space around the outer ball race are provided with a resilient material to act as a buffer when the bearing has moved sideways to its fullest extent. The illustration



shows a bearing applied to the upper end of a high-speed spindle *a* for spinning and like machines. The outer ball race *b* is loosely mounted in a housing *c* carried by the frame *d* of the machine. The race *b* is held in frictional engagement with the wall of the housing *c* by means of a compressible washer or spring *e*, which is clamped between the race *b* and a cap *f* screwed on to the housing *c*, and is preferably provided on its upper surface with a metal bearing surface *e*1. Loosely surrounding the race *b* is a washer *g* of felt, rubber or other compressible material, fitting against the inside of the housing. (*Sealed.*)